THE ENGINEER.

EXPLOSIVES IN 1891.

THE sixteenth annual report of her Majesty's Inspectors of Explosives has recently been issued, and its perusal gives some idea of the immense expansion which has of late years taken place in this branch of industry, consequent on the increased application of explosives to mining and engineering operations. Not including gunpowder, there are now some fifty-two explosives authorised for manufacture in or importation into the United Kingdom; and this list likewise excludes all preparations that come under the term ammunition, such as cartridges for cannon or small arms, fuzes, tubes, detonators, &c., as well as all fireworks. Of the above, about a dozen new ones have been added to the list during the past year; an unusually large number, but "exhibiting no striking new departure in explosives, as nearly all named are modifications or slight variations on previously existing substances." A similar remark applies to two others, respectively named "amberite" and "cannonite," which, though not formally authorised, have been passed, and factories are in process of erection for their manufacture. It is pointed out that there are a vast variety of smokeless or quasi-smokeless powders on the market at home or abroad, under a variety of names; but practically, all these may be classed under one of two heads, viz., those consisting essentially of nitro-cellulose, and those having the same material in conjunction with nitro-glycerine. Quick-firing ammunition—containing its own means of ignition—which previously was only licensed for direct issue to her Majesty's land and sea forces, is now allowed to be made for export by water transport at one factory on the banks of the Thames.

The total number of factories is now 125, exclusive of "small firework" and "toy firework' factories, being an increase of two on last year, four new ones having been licensed, and two ceased to exist. When the Explosives Act came into force fifteen years ago, the number of factories was fifty-five, but the increase in the number of factories alone does not sufficiently indicate the expansion of the trade, for we are told that there has been "a vast augmentation of the numbers of persons employed therein." By the last returns from the trade at the end of 1890, while the number of factories had increased 14 per cent., the number of persons employed in them had increased by no less than 31 per cent. All the above factories had been visited at least twice, and in some cases three times. Colonel Majendie, C.B., the senior inspector, is able to say that "there has been no falling off in the general improvement referred to in our previous reports. The highest standard of excellence, which has been gradually reached since the passing of the Explosives Act, has, as a rule, been fully maintained. We believe that, taken as a whole, the factories for explosives in the United Kingdom will compare very favourably with any other factories, whether in the United Kingdom or abroad." He also states: "Our relations with both employers and employed continue, we are glad to say, generally on the same satisfactory footing as they have now been for several years past." In only one case was the institution of legal proceedings actually necessary. In addition to the factories there are 372 magazines—being an increase of thirteen, all of which have been visited at least once during the year by H.M. inspectors, in addition to visits paid to a certain number of the "stores," under licence of local authorities, of which there are probably over 2000 in the United Kingdom. It is stated that the condition of these stores continues to advance in security, and that in no case during the year were prosecutions necessary, although in three instances was explosive in stores placed under seizure. In one of these cases 6200 lb. of gelatine dynamite was found to be stored, besides gunpowder and cartridges, in anticipation of a grant for a magazine licence. The "registered premises," where small quantities of explosives can be kept, in 1885 numbered 22,262, and the number is now considerably greater. A certain proportion of these were visited, and in nine cases proceedings were instituted for excess and careless keeping, by direction of her Majesty's inspectors, in addition to prosecutions by local authorities.

Accidents.—The accidents during the year were 144, resulting in 39 deaths, and 130 cases of injury; this number excludes all non-fatal mining accidents with gunpowder, which come under the cognisance of her Majesty's Inspectors of Mines. It is noted that nearly two-thirds of these accidents occur in the *use* of explosives, and under miscellaneous conditions to which the controlling powers of the Explosive Act do not apply; such conditions are chargeable with no less than 34 out of the 39 deaths, and 101 out of the 130 cases of injury. This leaves only 62 accidents, to which were due five deaths, and 29 cases of injury in manufacture, storage, and conveyance, these being the conditions to which the Act does apply.

The following tables, very much condensed and simplified from the report, exhibit at a glance the conditions under which the accidents took place, and the class of explosive involved:—

TABLE A.—*Accidents under Various Conditions.*

Condition.	Number of accidents.	Number of persons killed.	Number of persons injured.
(1) Manufacture	55	1	23
(2) Keeping	5	3	6
(3) Conveyance	2	1	6
(4) Use, &c.	82	34	101
Totals	144	39	130

TABLE B.—*Classification of Explosives.*

Class of Explosive.	Number of accidents.	Number of persons killed.	Number of persons injured.
Gunpowder	48	19	42
Nitro-glycerine* class	35	12	47
Nitro-cellulose† and nitro-benzol‡ class	9	3	4
Ammunition	34	—	25
Fireworks	14	4	7
Unknown	4	1	5
Totals	144	39	130

Manufacture.—It may be noted as a most satisfactory fact that only a single death occurred during the year in the processes of manufacture. In 1890 the number of deaths was eight, and the average for the last ten years seven. In contrast with these figures we have it stated that during the seven years before the Act came into operation the average number of deaths during manufacture alone was 39·5, and these figures were based upon incomplete returns. This very appreciable saving of life furnishes a striking testimony to the beneficial operation of the Act, and it would be more striking still, we are told, if the number of persons injured could be contrasted; it must also be remembered that the recent average of seven deaths is struck upon a vastly extended trade. We are told that it is "not a little remarkable that of the nine deaths during the last two years not one occurred in the manufacture of the newer explosives"—the nitro-compounds—"the whole occurring in two accidents in old-established gunpowder factories."

Keeping.—The number of accidents is rather above the average, and all but one occurred in "registered premises," where the supervision on the part of the local authority is often very defective.

Conveyance.—For the first time since 1888 there are two accidents, one of which caused the only death under this head since the Act came into operation.

Use and miscellaneous.—The number of these accidents is more numerous than in 1890, but the number of deaths rather less, viz., 34, as against 38, the average for the last ten years being 33·3. The number of persons reported injured, however, shows an increase, 101, as against 68, the average for the ten years being 84·9. The Act does not control the use of explosives, and all the Home-office Inspectors can do is to study the causes of the several accidents, and extract as much information and instruction from them as possible, for application by way of suggestion to those concerned. This is exemplified in the case of the repeated warnings issued by the inspectors, seconded by the Nobel Explosives Company and others, as to the great danger of thawing the nitro-glycerine explosives—which become congealed at a temperature as high as 45 deg.—except in the special apparatus provided for the purpose. The most serious accident from this cause in 1891 caused two deaths and injured two other persons. It is stated that "the accidents with explosives of the second division of the nitro-compound class, that group of explosives into which nitro-glycerine does not enter, such as gun-cotton, tonite, and roburite, &c., have been very few—five only—causing three deaths and injuring three persons. The only roburite accident was due to boring accidentally into an old unexploded hole," in which case, it is added, that "possibly the drill came into contact with the detonator." One of two accidents with securite was of a noticeable nature; "two men were burnt by a flame from a 'shot' of securite, but how exactly the men were burnt remains a mystery. The mines inspector satisfied himself it could not have been from the ignition of any gas or coal dust; but it would be even less reasonable to suppose that a nearly flameless explosive could have given out a flame which would burn one man at a distance of nine yards in one direction and a second man at a distance of six yards in another." Of the four deaths caused by fireworks during the year, three were caused by a single accident, the explosion of a "rocket sound signal" picked up by some children from the harbour at Wexford, into which it had been thrown as defective and useless. This sad accident caused the issue of a special circular by the Board of Trade relative to the disposal of such signals.

Foreign accidents.—Some of the more conspicuous accidents with explosives in foreign countries are noticed in the report, among which we may briefly refer to the terrible explosion of a magazine at Rome in April, 1891, of which a valuable report was furnished to the Foreign-office by Colonel Slade, C.B., our Military Attaché at Rome. The magazine contained "285 tons of gunpowder, 24,000 cannon cartridges, besides large quantities of various combustible military stores, such as fuzes, detonators, friction tubes, and fireworks. No nitro-compound was present." The great damage caused was fully reported to the daily papers at the time of the occurrence. The committee of investigation came to the conclusion that there can be no reasonable doubt that the cause of the explosion was the passing of a train within 200 yards of the magazine, which caused the spontaneous ignition of parachute or signal rockets, and laid stress upon the great danger of storing with gunpowder fireworks liable to spontaneous ignition. In this country, under no conditions whatever, military or civil, would such fearfully dangerous storage be permitted.

We read of an explosion on 9th April at Bradley's Nitro-Glycerine Factory at Petrolia, Ontario, by which the whole of the persons engaged—the exact number is uncertain—and the factory itself were destroyed. One of her Majesty's Inspectors visited this place in 1886, and it was impossible to conceive of a more carelessly constructed place; it was noted at the time of the above visit that "in this factory one probably touches the *nadir* of carelessness, and want of everything that should be observed for safety. Smoking appears to be the rule rather than the exception; in fact, Mr. Bradley appeared to select the moment of going into the 'danger building' to light his pipe."

At Newark, N.J., the Italians of the city were making merry, and fired small improvised "cannon" made of a piece of gas pipe, which they had loaded "with dynamite or gunpowder;" it exploded, and four persons were killed and twenty-two severely injured, some beyond hope of recovery. However, this incident may be capped by an occurrence which occurred in Lancashire. Some shells, picked up after gun practice in Morecambe Bay, were sold as old iron to a foundry. One of the workmen said, "I want to see if this is loaded or not," and poured into the shell some molten iron, with the result that there was an explosion, from the effects of which he died next day. The rash act was committed despite the warning of a brother workman. Various "dynamite outrages," at home and abroad, are also described.

In connection with our subject, we may here refer to the valuable report of a joint committee appointed by the Durham Coalowners' and Durham Coal Miners' Associations, which, after a series of experiments carried out in seven collieries for a period of more than eighteen months, made their conclusions public during the period under review. The object was to ascertain whether the fumes of certain high explosives were injurious to the health of the coal miners—those selected being tonite and roburite, as compared with gunpowder. Mr. Thomas Bell, her Majesty's Inspector of Mines, was appointed chairman of the committee; Professor P. P. Bedson, Dr. D. Drummond, and Dr. G. H. Hume, professional advisers; with Mr. M. W. Brown as mining engineer. The report was submitted to, and discussed by the Federated Institution of Mining Engineers, and recently published. Their main conclusions are tabulated as follows:—(1) That the products of the explosion of roburite and tonite are not more deleterious than those of gunpowder. (2) That no chemical evidence was obtained of the presence of nitro-benzene in the products of explosion, and that throughout the inquiry no case of nitro-benzene poisoning was met with. (3) That with regard to the production from roburite, tonite, and gunpowder of carbon-monoxide, the quantity found in average samples of air collected in the "place" is small, and is so quickly dissipated by the air current as to have been detected only in "traces" at an interval of five minutes after the firing of the "shot." (4) The committee base on the foregoing statement a strong recommendation that an interval of five minutes at least should be allowed to elapse after the firing of the shot before the hewers re-enter the place. (5) That as part of the gases detected in the fumes are produced by the burning of the fuse, it is recommended that the cartridges be fired by electricity. We are told that the worst results were probably better than the air in an ordinary theatre.

Regulations based upon the foregoing recommendation have been issued by H.M. Inspectors of Mines. It may be mentioned as one of the curiosities of "Crowner's Quest Law," that at a recent inquest upon a miner who died of meningitis three days after firing a roburite shot,—which, remarkably enough, was the first shot with that explosive ever fired in the colliery—although the above precaution had been duly observed, and the man proved to have been previously in weak health, the jury found that he had died from the effect of the fumes. The local medical attendant, while admitting that he had never known of a case of death resulting from meningitis in so short a time, was still of the opinion that the inhalation of roburite fumes was the immediate cause of death. Evidence

* Dynamite, blasting gelatine, gelatine-dynamite, &c.
† Gun-cotton, cotton powder, and tonite.
‡ Roburite, securite, and bellite.

was given by another miner that there was no unusual smell, and that the place was quite clear when he and deceased returned to where the shot was fired to get the coal. After an adjournment, Dr. Paul, Professor of Medical Jurisprudence, University College, Liverpool, deposed that he had examined the brain, blood, and viscera of the deceased, and failed to detect the presence of nitro-benzene, or of carbon monoxide. He further stated that, if the membranes of the brain were *inflamed*, he should have no hesitation in saying that death resulted from meningitis, and was therefore due to natural causes. A question asked in the House of Commons drew the reply from the Home Secretary that he had had competent expert opinions not in accordance with the verdict, and he mentioned also the conclusions of the Durham Joint Committee. Under these circumstances, Mr. Matthews "declined to prevent, under the Mines' Regulation Act, the use of an explosive which is largely used, and which has the advantage of being flameless." It is supposed that the fact that, had the verdict been "death from natural causes" the man's widow and children would have derived no benefit from the Miners' Relief Fund, may have tended to cause the jury to give them the benefit of the slightest doubt as to whether the fumes, or shock of discharge, might not have caused or accelerated his death.

THE BRITISH NAVY UNDER THE PRESENT ADMINISTRATION.

IN no department of the State has progress been more remarkable, under the present administration of the Government of the United Kingdom, than in that of the Royal Navy. In 1886, when Lord Salisbury took office, the condition of affairs at the Admiralty was entirely deplorable. We had battleships resting on the stocks, that had remained incomplete for years. We had others completed so far as the hulls went, but lying useless in the great fitting basins of our dockyards, as there were no guns to put into them. We had scarcely a fast cruiser in existence; and the majority of our war vessels were armed with muzzle-loading weapons of obsolete pattern; whilst the reserves of powder, ammunition, and equipment of all kinds had to be drawn upon to furnish the units of such ships as were actually required to be put in commission. This is an accurate picture of the State of things in 1886. We propose briefly to recapitulate some of the more important features characteristic of our Navy at that time, and then to exhibit the progress of development which has taken place since. In the present paper we shall confine ourselves to armoured vessels. "Facts are stubborn things," and we cannot do better than call attention to the accompanying statement, which gives a list of all ironclads of the British Navy completed or building in 1886; also of all ironclads completed or building at the present day, with detailed armament of each vessel as now apportioned. Practically the only ships which have been re-armed to any important extent are the Thunderer and Rupert, although a large number have been fitted with fighting masts and tops, so that the small quick-firing and machine-gun equipment has been considerably modified in them, the Gardiner gun having given place to the Nordenfeldt, and the Nordenfeldt 6 and 3-pounders to the Hotchkiss of similar class.

A glance at the statement shows that seventy-two ironclads were completed or building in 1886, including battleships, armoured cruisers, and coast-defence vessels. The total displacement of these was 524,870 tons. This looks grand; but in it are included the displacements of nineteen vessels which had never been to sea, and the majority of which were either only just laid down or had no guns to complete them. This reduces the available displacement by 158,500 tons. In contradistinction to this unhealthy condition as obtaining in 1886, what do we find by passing on to 1892? Not only has all the arrear of work—left as a legacy by the former Administration—been brought up, so that nineteen or twenty ships begun by it are now in commission all over the world, but a very considerable number of the earlier ironclads, which had been put aside for years, and rusted hopelessly at their moorings up dockyard creeks, have now been re-engined, re-masted, re-fitted, and partially re-armed, thus forming a most valuable adjunct to the more modern line-of-battle ships; whilst ten entirely new vessels, embodying all the most recent improvements in steel-faced armour, large calibre quick-firing guns, steel-casemated secondary batteries between decks, and possessing a higher rate of speed than any battleships actually afloat have been put in hand, and all—excepting the Centurion—will have been launched prior to August next. This brings the total displacement of the seventy-nine armoured vessels completed and building now to 643,760 tons, showing an increased quantity of tonnage amounting to 120,000 over that on hand in 1886.

But the increment in mere displacement, large as it looks, is in no way commensurate with the enormous output, in the shape of increased armament, which has taken place during the five and a-half years that have elapsed. Only three old ironclad vessels have been withdrawn from the navy list—the Lord Warden, old Repulse, and Waterwitch. So the total of muzzle-loading guns still stands at 405. The number of ordinary breech-loading guns has, however, gone up from 141 to 397, no less than 256 having been obtained from Woolwich or the trade under the present Administration. The number of small quick-firing and machine guns has also increased from 722 to 1513, whilst the inauguration of heavy quick-firers, of 4·7in. and 6in. calibre, has commenced with the respectable figure of 132. We have, in these totals, included the armament of many incomplete vessels, but this has been done designedly. In the first place, there is now a reserve of some natures, which would cover the requirements of some of these ships, if required to be hastily put in commission, and the manufacture of the rest is so well forward that by the time the ships are ready for them the guns will all have been delivered.

Speed in an ironclad is not so important a factor as it is in a fast cruiser; nevertheless, the improved degree of speed observable in the more recent vessels can hardly escape notice. The fastest battleship in 1886—for we necessarily exclude armoured cruisers—was the Impérieuse, which could get along in smooth water at 16·75 knots. The Royal Sovereign would, however, steam round her in a light breeze, and the Centurion or Barfleur will probably do their 18½ knots with ease.

Hence we are of opinion that the balance sheet of naval shipbuilding administration, to be handed over by Lord Salisbury, is a very healthy little document, and we commend it to the consideration of those who are anxious to revive the conditions of 1886.

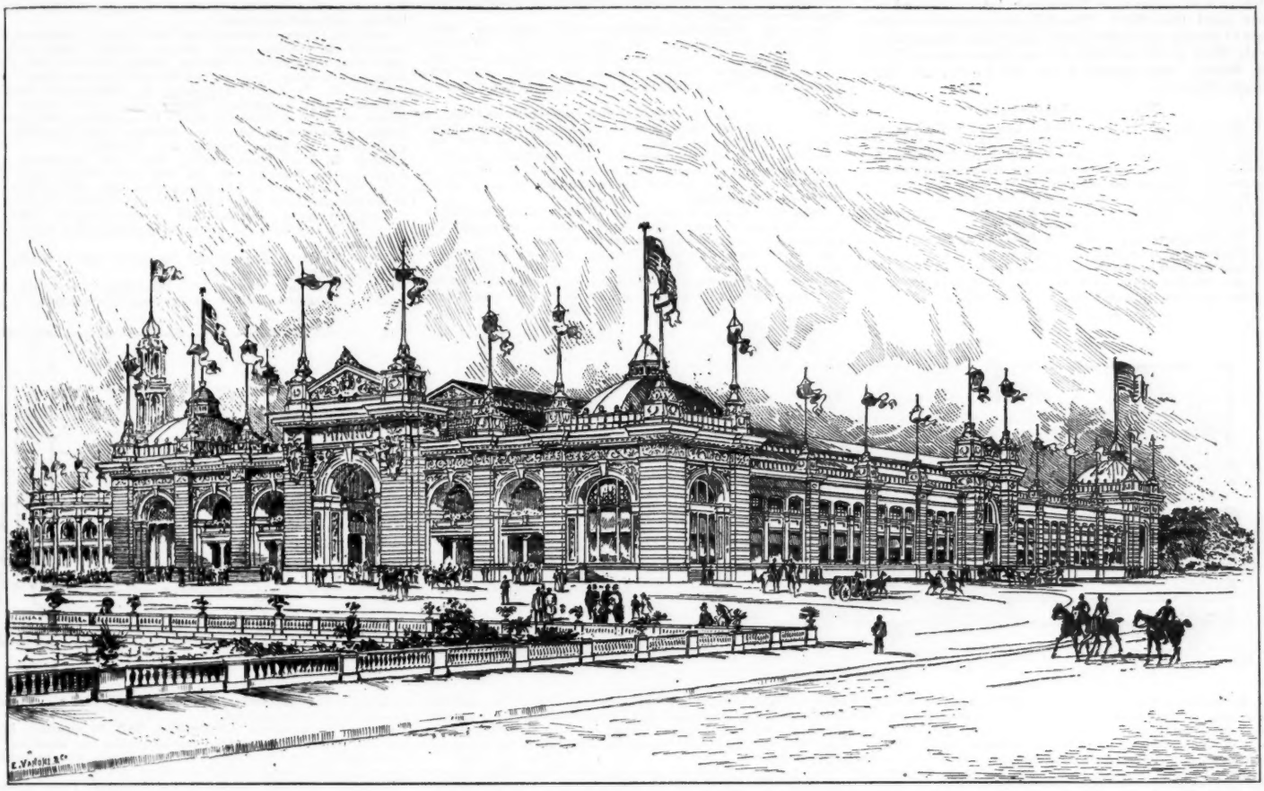
British Battleships and Armoured Cruisers, Completed and Building, at beginning and end of present Administration.

In 1886.	In 1892.	R.M.L. guns.		R.B.L. guns.						Machine and small Q.F.	Large Q.F.		Speed.	Date of completion.
		7", 8", 9"	10", 11, 12", 12½"	4" and 5"	6"	8" and 9"	10"	12"	13½" 16½"		4"·7	6"	(Knots.)	
Achilles	Do.	14	—	—	2	—	—	—	—	24	—	—	14·32	1864
Agamemnon ...	Do.	—	4	—	2	—	—	—	—	19	—	—	13·25	1883
Agincourt ...	Do.	17	—	—	—	—	—	—	—	16	—	—	14·8	1868
Ajax	Do.	—	4	—	2	—	—	—	—	19	—	—	13·25	1883
Alexandra ...	Do.	—	8	6	—	4	—	—	—	23	—	—	15·00	1877
Anson	Do.	—	—	—	6	—	—	—	4	26	—	—	16·75	1889
Audacious ...	Do.	10	—	8	—	—	—	—	—	16	—	—	13·2	1869
Aurora	Do.	—	—	—	10	2	—	—	—	22	—	—	18·5	1889
Australia ...	Do.	—	—	—	10	2	—	—	—	22	—	—	18·5	1888
	Barfleur	—	—	—	—	—	4	—	—	24	10	—	18·0	Building
Belleisle	Do.	—	4	—	—	—	—	—	—	15	—	—	12·20	1878
Bellerophon ...	Do.	—	—	6	4	10	—	—	—	16	—	—	14·17	1866
Benbow	Do.	—	—	—	10	—	—	—	2	22	—	—	16·75	1888
Black Prince...	Do.	26	—	—	2	—	—	—	—	11	—	—	13·60	1862
Camperdown...	Do.	—	—	—	6	—	—	—	4	26	—	—	16·75	1889
	Centurion	—	—	—	—	—	4	—	—	24	10	—	18·00	Building
Collingwood ...	Do.	—	—	—	6	—	—	4	—	26	—	—	16·5	1886
Colossus	Do.	—	—	—	5	—	—	4	—	20	—	—	15·5	1886
Conqueror ...	Do.	—	—	—	4	—	—	2	—	18	—	—	15·5	1882
Cyclops	Do.	—	4	—	—	—	—	—	—	9	—	—	11·0	1871
Defence	Do.	16	—	—	—	—	—	—	—	6	—	—	11·62	1862
Devastation ...	Do.	—	—	—	—	—	4	—	—	19	—	—	13·84	1873
Dreadnought...	Do.	—	4	—	—	—	—	—	—	15	—	—	14·20	1875
Edinburgh ...	Do.	—	—	—	5	—	—	4	—	20	—	—	15·5	1886
	Empress of India	—	—	—	—	—	—	—	4	33	—	10	17·5	Completing
Galatea	Do.	—	—	—	10	2	—	—	—	22	—	—	18·5	1889
Glatton	Do.	—	2	—	—	—	—	—	—	7	—	—	12·11	1872
Gorgon	Do.	—	4	—	—	—	—	—	—	9	—	—	11·14	1872
Hecate	Do.	—	4	—	—	—	—	—	—	8	—	—	10·90	1872
Hector	Do.	18	—	—	—	—	—	—	—	8	—	—	12·36	1864
Hercules... ...	Do.	6	8	—	—	—	—	—	—	29	6	—	14·0	1868
Hero	Do.	—	—	—	4	—	—	2	—	18	—	—	15·5	1888
	Hood	—	—	—	—	—	—	—	4	33	—	10	17·5	Completing
Hotspur	Do.	—	2	—	2	—	—	—	—	14	—	—	12·8	1871
Howe	Do.	—	—	—	6	—	—	—	4	26	—	—	16·75	1889
Hydra	Do.	—	4	—	—	—	—	—	—	9	—	—	11·0	1872
Immortalité ...	Do.	—	—	—	10	2	—	—	—	22	—	—	18·5	1889
Impérieuse ...	Do.	—	—	—	10	4	—	—	—	18	—	—	16·75	1886
Inflexible ...	Do.	80-ton	4	8	—	—	—	—	—	21	—	—	13·80	1881
Invincible ...	Do.	10	—	6	—	—	—	—	—	19	—	—	14·09	1870
Iron Duke ...	Do.	10	—	8	—	—	—	—	—	19	—	—	13·64	1871
Lord Warden...	—	18	—	—	—	—	—	—	—	8	—	—	13·50	1867
Minotaur ...	Do.	17	—	—	—	—	—	—	—	16	4	—	14·41	1867
Monarch... ...	Do.	3	4	—	—	—	—	—	—	22	—	—	14·94	1869
Narcissus ...	Do.	—	—	—	10	2	—	—	—	22	—	—	18·50	1889
Nelson	Do.	8	4	—	—	—	—	—	—	27	4	—	14·41	1880
Neptune... ...	Do.	2	4	—	—	—	—	—	—	25	—	—	14·20	1878
Nile...	Do.	—	—	—	—	—	—	—	4	23	6	—	16·5	1890
Northampton ...	Do.	8	4	—	—	—	—	—	—	24	—	—	13·2	1878
Northumberl'd	Do.	27	—	1	1	—	—	—	—	15	6	—	14·13	1868
Orion	Do.	—	4	—	—	—	—	—	—	14	—	—	13·0	1882
Orlando	Do.	—	—	—	10	2	—	—	—	23	—	—	18·5	1888
Penelope... ...	Do.	8	—	—	—	—	—	—	—	15	—	—	12·76	1868
Prince Albert	Do.	4	—	—	—	—	—	—	—	6	—	—	11·65	1866
	Ramilies	—	—	—	—	—	—	—	4	33	—	10	17·5	Completing
	Repulse	—	—	—	—	—	—	—	4	33	—	10	17·5	Do.
	Resolution	—	—	—	—	—	—	—	4	33	—	10	17·5	Building
	Revenge	—	—	—	—	—	—	—	4	33	—	10	17·5	Do.
	Royal Oak	—	—	—	—	—	—	—	4	33	—	10	17·5	Do.
	Royal Sovereign	—	—	—	—	—	—	—	4	33	—	10	18·00	1892
Repulse	—	12	—	—	—	—	—	—	—	8	—	—	12·28	1870
Rodney	Do.	—	—	—	6	—	—	—	4	24	—	—	16·75	1888
Rupert	Do.	—	—	—	2	2	—	—	—	13	—	—	13·59	1874
Sans Pareil ...	Do.	—	—	—	12	—	1	—	2	29	—	—	16·75	1889
Scorpion... ...	Do.	4	—	—	—	—	—	—	—	6	—	—	10·51	1865
Shannon... ...	Do.	7	2	—	—	—	—	—	—	11	—	—	12·35	1877
Sultan	Do.	4	8	7	—	—	—	—	—	17	—	—	14·13	1871
Superb	Do.	—	16	6	—	—	—	—	—	22	—	—	13·50	1880
Swiftsure ...	Do.	10	—	8	—	—	—	—	—	20	—	—	13·75	1872
Temeraire ...	Do.	—	8	6	—	—	—	—	—	20	—	—	14·50	1877
Thunderer ...	Do.	—	—	—	—	—	4	—	—	18	—	—	13·40	1877
Trafalgar ...	Do.	—	—	—	—	—	—	—	4	24	6	—	16·5	1890
Triumph... ...	Do.	10	—	4	—	—	—	—	—	21	—	—	13·75	1873
Undaunted ...	Do.	—	—	—	10	2	—	—	—	22	—	—	18·5	1889
Valiant	Do.	18	—	—	—	—	—	—	—	8	—	—	12·65	1865
Victoria	Do.	—	—	—	12	—	1	—	2	29	—	—	16·75	1890
Viper	Do.	2	—	—	—	—	—	—	—	—	—	—	9·59	1867
Vixen	Do.	2	—	—	—	—	—	—	—	—	—	—	8·89	1866
Warrior	Do.	32	—	—	—	—	—	—	—	8	—	—	14·40	1861
Warspite ...	Do.	—	—	—	10	4	—	—	—	18	—	—	16·75	1888
Waterwitch ...	—	2	—	—	—	—	—	—	—	—	—	—	8·88	1867
Wivern	Do.	4	—	—	—	—	—	—	—	—	—	—	10·06	1865
72 ships	79 ships	327	110	74	189	38	18	16	56 6	1529	52	80		19 ships left unfinished now complete

Tons.	Tons.	Total M.L. guns.	Total B.L. guns.	Machine & small Q.F.	Tot'l large Q.F.
524,870	643,760	437	397	1529 ...	132
Deduct armament of Lord Warden, Old Repulse, and Waterwitch, now withdrawn		32	—	16	—
Existing armaments		405	397	1513 ...	132
Provided by present Administration		Nil.	256	791 ...	132
Legacy of old Administration in 1886		405	141	722 ...	Nil.

MUDD'S PATENT EXPANSION CYLINDERS FOR TANK STEAMERS AND STORAGE TANKS.—Mr. Thomas Mudd, of the Central Engine Works, West Harlepool, has patented an invention which promises to possess considerable value. In tank steamers carrying oil in bulk there is required what now go by the name of expansion tanks or trunks. These are usually rectangular trunks at the top of the oil-carrying holds, in which the oil can rise when it expands in bulk, due to rise in temperature, thus preventing the bursting of the ship. The oil hold is filled with oil sufficiently to bring the surface of the oil some little distance into the expansion trunk, so that every part of the hold is quite filled with oil except the upper part of the trunk. There is a cover put over the trunk, and a ventilator projects through the cover so as to let out gas or let in air as the oil level rises or falls. The mouth of the ventilator is generally covered with gauze, to prevent sparks, &c., finding their way into the explosive mixture of gas and air that exists in the upper part of the expansion trunk. The free ingress and egress of gas and air into and out of the space in the expansion trunk above the oil leaves still a certain element of danger in this arrangement, as the ship practically carries about with her these trunks or boxes filled with a more or less explosive mixture. To obviate this danger Mr. Mudd proposes to replace the expansion trunks by expansion cylinders, which are bored out and fitted with pistons. The upper end of the cylinder is open to the atmosphere, being merely roofed in for shelter, and the lower end is open to the oil hold, and fitted with stops to prevent the piston falling out at the bottom. The piston would lie upon the surface of the oil just as the ram lies upon the water in a hydraulic cylinder or pump, without any space between, thus entirely doing away with the gaseous space now existing over the surface of the oil in the usual expansion trunks. It will be at once seen that this arrangement allows for expansion of the oil, whilst at the same time it keeps it entirely enclosed from the atmosphere, for as the oil expands in bulk it lifts the piston in the cylinder, thus making more room for itself, and when it contracts the weight of the atmosphere above pushes the piston down, keeping it always in contact with the surface of the oil. No air whatever would be allowed access to the under side of the piston, and if any gas accumulated there it would be harmlessly discharged at intervals, if thought desirable, by means of a small pipe and cock attached to the piston and passing up to a considerable height above it, the cock being shut and locked as soon as the gas was discharged.

THE CHICAGO INTERNATIONAL EXPOSITION, 1893—MINES AND MINING BUILDING



MINES, MINING, AND METALLURGY AT THE CHICAGO EXHIBITION.

THE mining and metallurgical arts and industries will be more comprehensively and completely dealt with as an exhibit at the Chicago Exposition than at any other international exposition, and from their intimate relation with other arts and industries, will be of general interest to technical visitors. The scope of the exhibits will include all economic and precious minerals, the precious stones and gems, coals and mineral oils, building and ornamental stones, sands and clays, salts and pigments, and the machinery, implements and appliances used in obtaining the natural products and converting them to various uses. The coal resources of all countries will be represented by a series of geological maps and drawings, showing the extent and accessibility of the great number of coal beds and veins which underlie the earth's surface. There will also be samples of various kinds, but these will be carefully arranged so as not to be mere unmeaning masses of coal. The iron industries and resources will of course be extensively represented, and the wonderful development of the resources of the southern United States—the "New South"—will be shown. There will be exhibits indicating the location and extent of the greater deposits, analysis of the ores, and the various machinery and plant employed in mining, hoisting, conveying, storing, &c. Mining machinery and tools of every kind, crushing and separating machines, smelting, and refining works, and complete metallurgic processes from mineral to metal will be shown by drawings, models, specimens, &c., including working models of coal and other mines. The tools and appliances employed for boring and drilling wells for water, petroleum, and natural gas will be of much interest, as well as the means for conveying and utilising the oil and gas. Besides the ores and raw material, there will be bars and ingots and finished products of the baser metals and of the higher metals, such as silver, aluminium, nickel, &c. In the mining machinery section will be shown every kind of apparatus, simple and complex, employed in working a mine from the drift to the dump; methods of timbering; sinking shafts and driving galleries; draining, ventilating, and lighting; drilling and breaking down; quarrying and tunnelling; loading, hoisting, and dumping; cars and automatic dumps; rock breakers and screens; wire ropeways and carriers; steam excavators; coal tips and coal washers; gold amalgamators and stamp mills; ore-washing, concentrating, separating, and refining, &c. &c. There will be numerous classified collections of ores and specimens, exhibited by institutions and private collectors, and also numerous maps, plans, photographs, engineers' working drawings, and much statistical and literary matter. Much attention is also being given to the historical collection, including specimens of ancient tools and work, and illustrating the development and growth of mining methods and metallurgical processes up to their present stage. In order to economise space, much of the machinery will be represented by working models of quarter size, the motive power being supplied by electric motors, but there will also be large exhibits of working machinery, including a full size ore-conveying plant.

The accompanying view represents the mines and mining building, the architect of which was Mr. S. S. Beman, of Chicago. The building is in the style of the Italian Renaissance, liberally treated. Its general dimensions are 350ft. by 700ft., covering an area of 5⅝ acres, and its cost is about 260,000 dols. The height of the main cornice line is 65ft. above the ground, which is the height of wall adopted for all the main buildings. There are four main entrances, those in the north and south ends being the principal, having pavilions 110ft. high and 88ft. wide, with arched openings 32ft. wide and 56ft. high. The view shows the north and west sides of the building. The corner pavilions are 68ft. wide and 96ft. high, each surmounted by a low dome. Between the main entrances and the pavilions are arcades forming an open loggia on the main floor, and a recessed promenade on the gallery floor. These covered promenades are each 25ft. wide and 230ft. long, and have numerous points of access to the building. These loggias are faced with marbles and other ornamental stones, forming an appropriate exhibit. The main fronts of the building are embellished with sculptural and decorative designs emblematic of mining and the allied industries. The exterior covering and decorative work is of the plaster composition known as "staff," and is coloured an ivory tint, which will be relieved by the gay colours of numerous flags and banners.

The central portion of the building is of steel construction, and obstructed only by sixteen columns supporting the roof trusses. The greater part of the roof is of glass, and the end gables of the main roof are also filled in with glass. This central portion covers an area of 230ft. by 580ft., in the centre of which is a circular court 44ft. diameter, in which will be erected an emblematic design. From this court will run four main aisles 20ft. wide, as shown in the floor plan, Fig. 1, dividing the main floor into four sections, 278ft. by 94ft., or 26,130 square feet each. Outside of this main floor will be a floor space 60ft. wide on every side, contained in the surrounding timber construction shown in the cross section. In addition to this there will be 103,000 square feet of floor space afforded by the gallery, the plan of which is shown in Fig. 2. The gallery is 60ft. wide, and 25ft. above the floor, extends round the building, and is approached by eight stairways. This gallery will be used for special and private collections, cabinets of specimens and precious stones, photographs and drawings, &c. The building will also contain refreshment-rooms, reading and toilet-rooms, &c., as shown by the plan. The railway cars with exhibits will be run right up to the building, where the heavy machinery, &c., will be handled by a locomotive crane and placed upon cars running on the installation tracks, other cranes being used to hoist the heavy articles and place them in position. Turntables will enable these cranes and cars to be handled properly and easily, and the cranes will be of fifteen tons capacity. The floor is calculated for a load of 150 lb. per square foot.

The main part of the building is surrounded by a timber framework structure 60ft. wide, as shown by the cross section, Fig. 3. There are four rows of columns, spaced 64ft. 6in. centre to centre longitudinally, and carrying the main trusses. The centre span is 115ft. wide, with two side spans of 57ft. 6in. The main roof trusses are on the cantilever principle, and the roof is the largest ever built on this system. Each cantilever is 92ft. long, with an anchor arm 57ft. 6in. long, forming the truss for the side span, and a cantilever arm 34ft. 6in. long. The ends of these arms support the central suspended span, which is the truss for the clearstory roof, and is 46ft. span. A crib anchorage of the outer columns resists the upward strain. The side or outer columns are 43ft. high, the main columns 63ft. 2in., and the height from floor to top of clearstory roof is 95ft. The main structure contains about 7800 tons of steel, while the surrounding wooden structure contains about 4,800,000ft. of timber. The outer columns are built up of two plates, 16in. by ⅝in., with corner angle irons, and connected by lacing bars, 2½in. by ⅝in., the cross section being 16in. by 18¾in. The cap plate is 17in. by 20in., and the shoe has a base of 24in. by 27in.

The main columns have four solid sides, and are built up of two plates 30in. by $\frac{7}{16}$in.; four plates 18in. by ⅝in.; and four angles 4in. by 4in. by ½in. The cross-section is 30in. by 18in., and at a height of 8ft. from the floor the sides flare outward to the shoe, which has a base of 8ft. by 2ft.

The trusses are of the pin connection type, and the arrangement of members is clearly shown by the cross-section. Owing to the great distance of 64ft. 6in. between the ten trusses, unusually large purlins were required, and these are of rivetted construction. Those over the outer columns are Warren girders 5ft. deep, built up entirely of angle irons, and having good sized junction plates to provide for ample rivetting. The purlins over the main columns are lattice girders, 10ft. 6in. deep, the diagonals being 3in. by 3in. angles. The purlins at the ends of the cantilever arms are Warren girders 7ft. 2in. deep, with an upper extension 9ft. 7in. deep, which forms the side of the clearstory roof, making the total depth 16ft. 9in. The top and bottom chords of the trusses have two sides of plates and angles, and two of lacing bars. These bars do not intersect, being arranged as in a Warren girder, and are not therefore "lattice" bars.

The central structure is entirely of steel conforming to the specifications prepared by the engineers of the Exposition. No specific process of manufacture is required, but no steel is to contain more than 0·08 per cent. of phosphorus, and test bars are to have a tensile strength of 60,000 lb. to 68,000 lb. per square inch, an elastic limit of at least half the tensile strength, an elongation of not less than 24 per cent., and a reduction of area of not less than 40 per cent. Rivet steel must have a tensile strength of 52,000 lb. to 58,000 lb., with an elastic limit, elongation, and reduction of area, as above, and must be capable of bending double without sign of fracture. The shearing strain on steel rivets and pins must not exceed 10,000 lb. per square inch, and the pressure in the semi-intrados of the rivet and pin holes 20,000 lb. The extreme fibre strain for pins is 25,000 lb. per square inch. Machine rivetting is to be used where practicable. The erection of the work was carried on without special difficulty or incident, and was completed in December, 1891, by which time the timber construction was also well advanced, and the building is now practically completed.

Electric motors will be placed at intervals throughout the building for the purpose of furnishing motive power for machinery and working models. The lighting will be very efficient, including 3000 incandescent lamps on the

Westinghouse alternating current system, and probably a certain number of arc lamps. Extensive foreign exhibits are already arranged for, and about 75,000 square feet have been reserved for this purpose. The reception of exhibits will commence November 1st, 1892, and will close April 10th, 1893. The following rules and regulations in regard to exhibits have been prepared and issued by Mr. Fred. J. V. Skiff, Chief of the Department of Mines and Mining, and approved by Mr. George R. Davis, Director-General:—

RULES AND REGULATIONS.

(1) Space granted to an exhibitor may be utilised in such manner as the exhibitor may determine. But before permits to occupy allotted spaces are issued, full detailed information, describing the proposed exhibit, showing general design, elevation, construction, decorations, material to be used, &c., must be submitted to the chief of the department for approval.

(2) No exhibit shall be more than 20ft. in height, except by consent of the chief of the department.

(3) Partitions must not exceed 12ft. in height.

(4) Platforms must be 10in. high, no more nor less.

(5) Railings must be 3ft. in height from the floor.

(6) All covered spaces must be open, at least in front, and supports or columns must not exceed 12ft. in height.

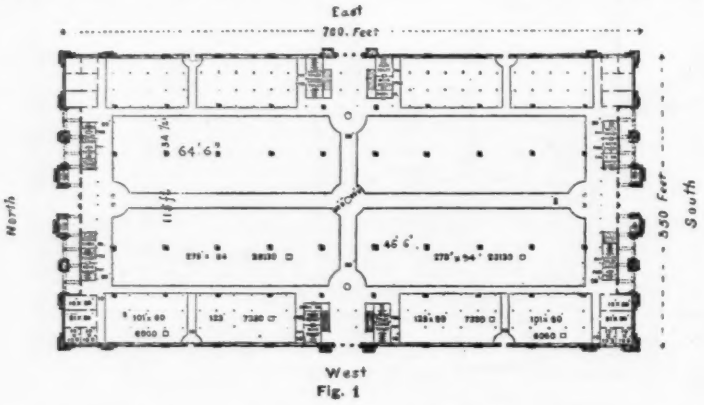


Fig. 1

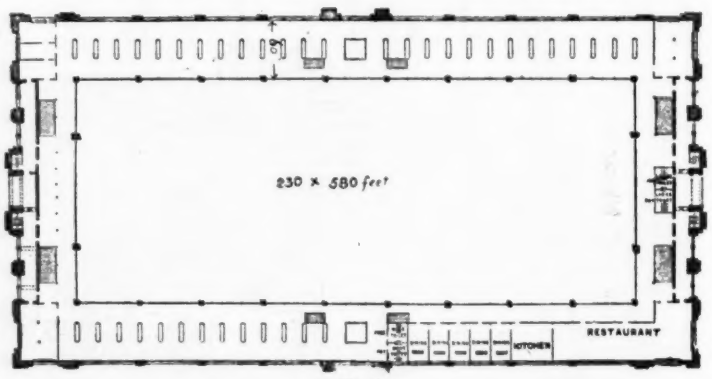


Fig. 2

(7) No portion of the flooring of the building can be removed or cut into by exhibitors except by special permission of the chief of the department.

(8) Exhibitors of mining machinery or processes must be either the manufacturer or inventor of said machinery and processes, but the manufacturer or inventor may specially appoint an agent to make such exhibit, such appointment to be certified to and indorsed by the Director-General.

(9) All exhibits of machinery in motion must be enclosed by a railing not less than 3ft. in height from the floor, and no machinery in motion can be located within 3ft. of any aisle or passage way.

(10) The power provided for the mines and mining building will be electricity and compressed air. Electric, air, gas, water, and sewer mains will be laid by the Exposition. All connections for power, water, or sewerage must be made at the expense of the exhibitor.

(11) Space for raw material used in demonstration will require a special permit, and all product or refuse resulting from such demonstration must be removed each day.

(12) All mineral in cabinets must be plainly labelled, giving at least the scientific name and the locality of the specimen.

(13) All ores must have affixed or attached thereto information as to the character of the specimen, location of deposit, and rough analysis. Such other data as will be of interest to the public may be given at the discretion of the exhibitor.

(14) All coals must bear a card or tag, giving variety and tests and location of mine and output.

(15) All building stones must bear a card or tag, giving popular name and tests, and location of quarry.

(16) No piece of ore or coal shall exceed 3ft. in diameter, except by special permission of the chief of the department.

(17) Exhibits of building and ornamented stone must be in cubes, and should not be more than one foot square; one side at least must be finished.

(18) Upright cabinets, to conform to general design, should have a base 1ft. high, a glass front 6ft. in height, a 6in. cornice, be 1ft. in depth, and either 5ft. or 10ft. in width. A preferable size for flat cases is 4ft. by 5ft. and 1ft. deep.

(19) Slabs of marble, onyx, &c., whether rough or polished, pavement slabs, artificial stone, set cement, tiling, &c., must not exceed 4ft. square in superficial dimensions.

(20) Permits for space will not be transferrable.

(21) Safety vaults can be secured for the safe keeping and protection of exhibits of unusual value.

(22) The chief of the department reserves the right to construe, modify, or amend these rules and regulations.

The department of mines, mining, and metallurgy is known as Department E, and is divided into twenty-seven groups, and sub-divided into 123 classes. The following abstract of the classification is of interest, as showing clearly the scope of the department and its exhibits, and will also be useful to intending exhibitors.

DEPARTMENT E.—MINES, MINING, AND METALLURGY.

Group 42, Minerals and Ores: Collections of minerals and ores systematically arranged; native metals; diamonds, gems and crystals—rough and uncut and unmounted; geological specimens, including systematic arrangement of specimens illustrating the formation of the earth.

Group 43, Mineral Combustibles: Coal, anthracite, semi-butiminous and butiminous; coal waste, slack, coke, and pressed coal. Asphaltite and asphaltic compounds—uintaite, wortzilite, grahamite, albertite, bitumen, mineral tar, amber. Petroleum, illuminating and lubricating oil. Natural gas, methods of conveying and using.

Group 44, Stones for Building and Decoration, and Quarry Products: Building stones, granites, slates, &c., rough hewn, sawed, or polished; for buildings, bridges, walls, or other constructions, or for interior decoration, or for furniture. Marbles—white, black, and coloured—onyx, silicified wood, agates, jaspers, porphyries, &c., used for building, decoration, statuary, monuments, vases or furniture.

Group 45, Grinding, Abrading, and Polishing Substances: Grindstones, whetstones, hones; sand, quartz, diamond, corundum, &c., for polishing; emery in the rock and pulverised.

Group 46, Graphite and its Products, Clays and other Fictile Materials and their Direct Products, Asbestos, &c.: Crude graphite and graphite compounds, lubricants, pencils, crucibles, &c.; clays, kaolin, silex and other materials for the manufacture of porcelain faience and of glass, bricks, terra-cotta, tiles, and fire-brick; refractory stones for lining furnaces—sandstone, steatite, &c.—and refractory furnace materials, mica, bauxite clay for the manufacture of aluminium; asbestos, crude and manufactured; meerschaum.

Group 47, Limes, Cement, and Artificial Stones: Lime, cement and hydraulic cement, raw and burned, accompanied by specimens of the crude rock or material used; also artificial stone, concrete, beton; specimens of lime mortar and mixtures, with illustrations of the processes of mixing, &c.; hydraulic and other cements; beton mixtures, with illustrations of the processes; artificial stone for building purposes and artifical stone mixtures for pavements, walls, or ceilings; asphaltic mastics and mixtures; gypsum, crude and boiled; plasters, mastics, &c.

Group 48, Salts, Sulphur, Fertilisers, Pigments, Mineral Waters, and Miscellaneous Useful Minerals and Compounds: Salt from beds or from brines; nitre and other nitrates; sulphates, alums, and other salts; sulphur and pyrites for the manufacture of sulphuric acid; boracic acid and its salts; borax; pigments, iron oxides, ochres, vermilion, &c.; mineral fertilising substances, gypsum, phosphate of lime, marls, shells, coprolites, &c., not manufactured; mineral waters and artesian well water.

Group 49, Metallurgy of Iron and Steel, with the Products: The mixtures, fluxes, and fuels; blast furnaces; pig iron and cast iron; cupola furnaces; direct processes; sponge and blooming plant; puddling; Bessemer machinery; basic process; open hearth steel; crucible, nickel, chrome, aluminium, tungsten, and other steel; manganese iron and steel; bars, rods, sheets, and wire.

Group 50, Aluminium and its Alloys: Aluminium, pure and commercial; ingots, castings, wire, sheets, &c.; aluminium alloys; process of extraction of aluminium; electric reduction.

Group 51, Copper and its Alloys, Metallurgy: Native copper, and the methods of extracting, melting, and refining it; ores and their treatment by fire; smelting; pneumatic process; converter system; extraction in the "wet" way; ingots, bars, &c., with specimens illustrating various stages of production; copper and zinc; brass industry, and products; copper and aluminium, aluminium bronze.

Group 52, Metallurgy of Tin, Tin-plate, &c.: Tin ores and their treatment; block tin and its extraction from ore; tin-plate and methods of cleaning and coating iron and steel plates.

Group 53, Metallurgy of Zinc, Nickel, and Cobalt: Spelter, zinc, zinc oxide; nickel in ingots, bars, rods, sheets, and wire; nickel-covered steel and iron by rolling; nickel "plating;" nickel salts; special nickel alloys, as German silver, &c.; nickel steel.

Group 54, Metallurgy of Antimony and other Metals not specifically classed: Antimony and compounds; arsenic and orpiment; bismuth and alloys; quicksilver and amalgams.

Group 55, Extraction of Gold and Silver by Milling: Gold and silver mills and accessories; amalgamation; handling quicksilver; retorting, melting, stamping, and shipping bullion.

Group 56, Extraction of Gold and Silver by Lixiviation: Roasting and chloridising furnaces; chlorination and other processes.

Group 57, Extraction of Gold, Silver, and Lead by Fire: Furnace plant and appliances; lead bullion moulds and bars; refining operations.

Group 58, Quarrying and Working Stone: Quarrying, cutting, and channelling engines; derricks and fittings; slate-cutting, sawing, and planing machines; machines and apparatus for cutting, turning, and polishing stones.

Group 59, Placer, Hydraulic, and Drift Mining: Apparatus and machines for washing gravel; sluices, cradles, toms, rockers, riffles, &c.; construction of ditches, flumes, penstocks, &c.; pipes for conveying water; "giants," nozzles, and appurtenances.

Group 60, Tools and Appliances of Underground Mining, Timbering, and Supporting: Timber-cutting and framing machines; methods of timbering shown by examples, underground chutes, gates, and appliances for delivering ores; methods and appliances for ventilating, lighting, and signalling.

Group 61, Boring and Drilling Tools and Machinery, and Apparatus for Breaking out Ore and Coal: Picks, gads, and hammers; hand drills and blasting implements; drilling by steam or compressed air and power drills; diamond drills for prospecting, sinking, and driving; well and shaft boring; boring for water, oil, or gas—tools and methods; machines, apparatus, and implements for cutting coal.

Group 62: Pump, Engines, and Apparatus used in Mining for pumping, draining, and hoisting.

Group 63, Mining, Storing, and Delivering Ores, Coals, &c.: Tramways, turntables, automatic hoisting, and conveying on the surface; loading and unloading contrivances; cars of all kinds; automatic dumping, ore bins.

Group 64, Apparatus for Crushing and Pulverising: Rock breakers, rolls, stamps, mortars, revolving mills, coal breakers.

Group 65, Sizing Appliances: Screens, sieves, and perforated plates; sizing by currents of air and water, and by belts.

Group 66, Assaying Apparatus and Fixtures: Plans of assay offices, furnaces, muffles and appliances. Scorification and cupelling, volumetric methods and apparatus, fluxes and their receptacles, assay balances, assay tables and methods.

Group 67, History and Literature of Mining and Metallurgy: Class 410—Maps, relief models and pictures, to illustrate the geology and distribution of minerals and mines, and the methods of working mines. Class 411—History and statistics of mines and mining districts; charts, diagrams and tabular representations; statistics of mineral production. Class 412—Mine engineering—surface and underground surveying and plotting, projection of underground work, location of shafts, tunnels, &c.; surveys for aqueducts, drainage, and for ascertaining the nature and extent of mineral deposits. Boring and drilling rocks, shafts and tunnels, &c. Construction—sinking and lining shafts by various methods, driving and timbering tunnels, and the general operations of opening, stopping, and breaking down ore; timbering, lagging and masonry. Hoisting and delivering at the surface, rock, ore or miners; pumping and draining by engines, buckets or by adits. Ventilating and lighting.

Group 68, Originals or Reproductions of early and Notable Implements and Apparatus used in Mining and Metallurgy.

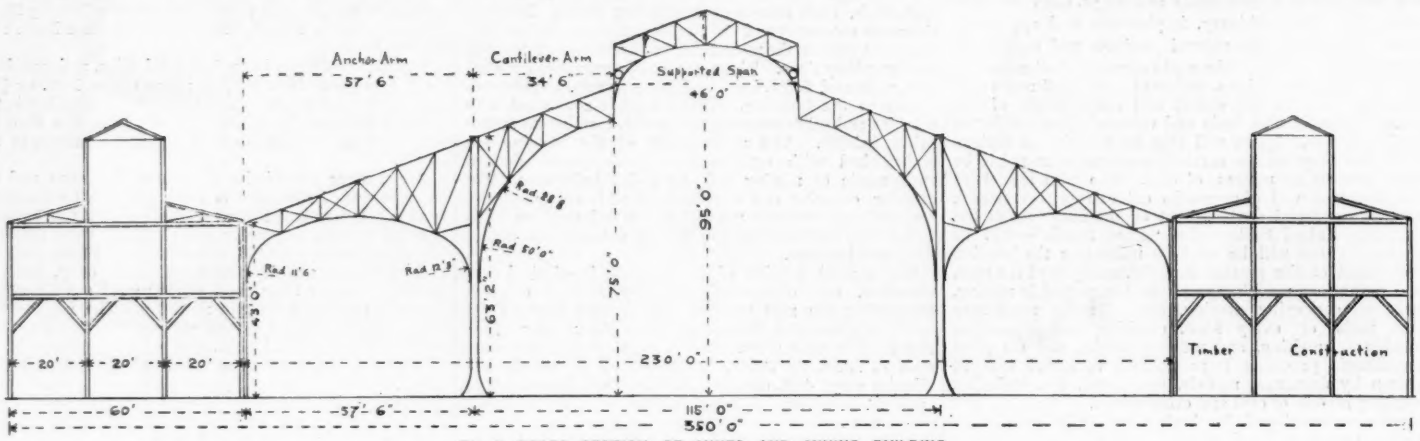


Fig. 3—CROSS SECTION OF MINES AND MINING BUILDING

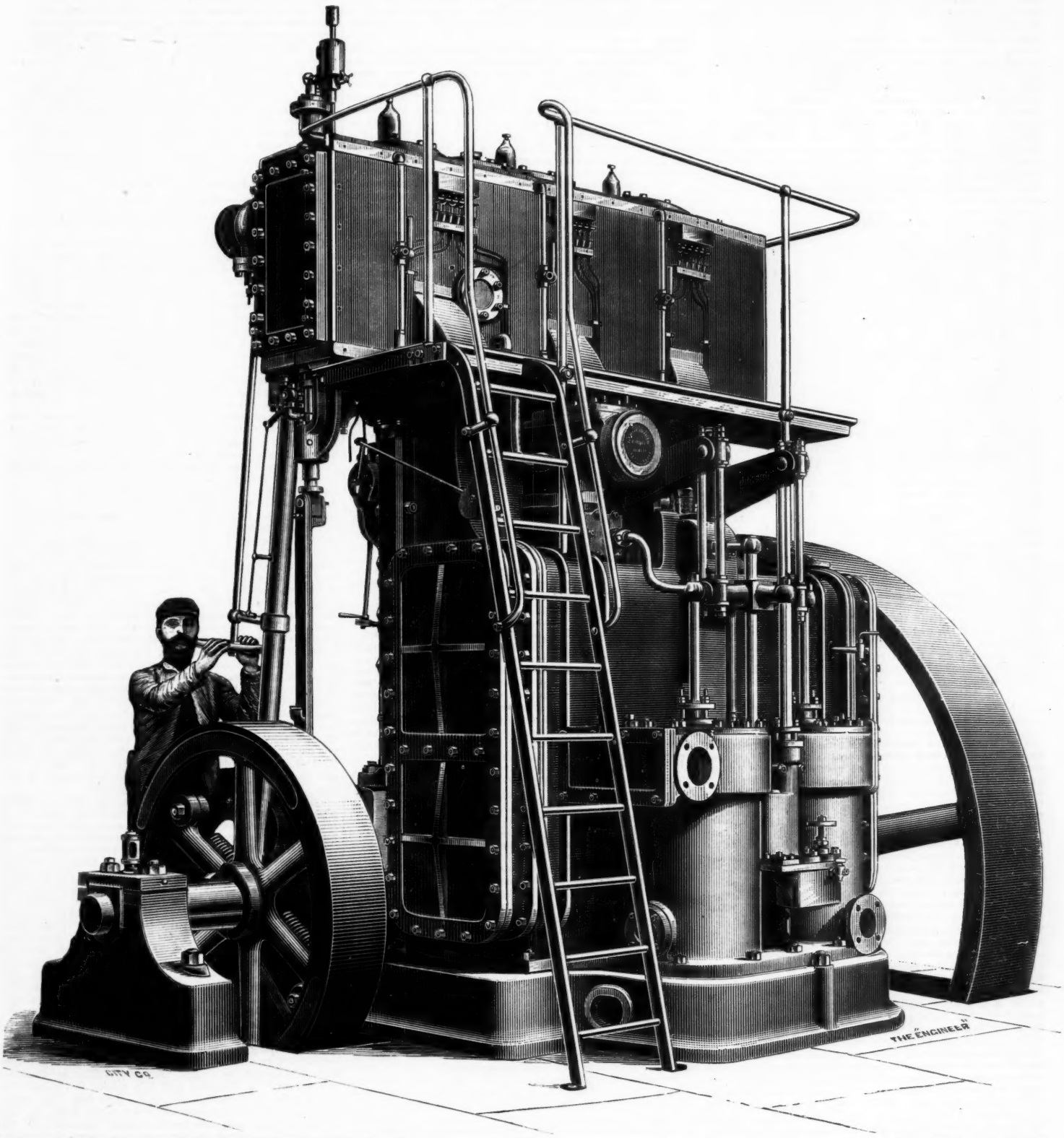
A very large amount of work has already been done by the Traffic Department in the line of arranging for the proper transportation of exhibits and the securing of reduced rates on the same. Material reductions have been made by all of the leading railway lines of the country. It may be generally stated that full tariff rates will be charged on exhibits on the forward journey, the same being returned free to point of shipment, *viâ* the same route first used, and provided the ownership of the goods exhibited remains unchanged. Freight charges must be prepaid at the point of shipment, the goods being delivered at the Exposition clear of all charges incident to the transportation. To the freight rates must be added a sum not exceeding 8c. per 100 lb., which is a terminal charge covering the switching of exhibits into the grounds from the railway, and the placing of the exhibits on the space allotted.

Exhibitors will not be charged for space. A limited amount of power will be supplied gratuitously. This amount will be settled definitely at the time space is allotted. Power in excess of that allotted gratuitously

TRIPLE EXPANSION CONDENSING ENGINES, OXFORD CENTRAL ELECTRIC LIGHTING STATION

MESSRS. J. AND H. McLAREN, LEEDS, ENGINEERS

(*For description see page* 16)



will be furnished by the Exposition at a fixed price. Demands for such excess must be made before the allotment of space. No single piece or section of any exhibit of greater weight than 30,000 lb. will be accepted if machinery is required for its installation. Exhibitors must provide, at their own expense, all show-cases, cabinets, shelving, counters, fittings, &c., which they may require, and all counter-shafts, pulleys, belting, &c., for the transmission of power from the main shafts. Exhibitors will be confined to such exhibits as are specified in their application.

All the leading mineral-producing and metallurgical countries will participate, and in most of the separate States of the United States, special committees or superintendents have been appointed to undertake the collecting and arranging of the State exhibits for this department.

THE INSTITUTE OF NORTH-EAST COAST SHIPBUILDERS AND ENGINEERS.

ON Friday last, June 24th, the members of the Institute of North-East Coast Shipbuilders and Engineers visited the Atlas Works at Sheffield, upon the invitation of the proprietors, Messrs. John Brown and Co., which invitation was largely accepted by the members from the Tyne and the Wear, as well as by smaller contingents from London, Liverpool, and Belfast, the total number of visitors being nearly 300. The main party, with the President of the Institute, Mr. Robert Thompson, of Messrs. J. L. Thompson and Sons, Sunderland, the Council, and Mr. J. Duckill, the secretary, arrived by train from Newcastle *vid* York, but owing to the Board of Trade regulations, which forbid the use of the works' sidings by passenger trains, they were landed at Attercliffe-road and conveyed in brakes to the works' gate nearest to the armour plate mill, where the first item of the programme—which had been arranged with much care in order to show each of the special operations for which the works are noted in full operation—was the rolling of a compound steel plate on Ellis's system intended for the barbette armour of H.M.S. Revenge, a battleship now building at Messrs. Palmer's Works at Jarrow, and was followed by the rolling of a back iron plate for the same ship, and a Purves ribbed flue plate; a special staging, accommodating 200 persons, having been erected to enable the largest possible number of the party to obtain a good view of the mill and furnaces. The manufacture of armour plates at the Atlas Works commenced in 1859 with malleable plates, whose thickness increased with the progression in the demands of naval architects from 4in. to 24in. The making of compound plates on Mr. Ellis's system began in 1877, and since that time that kind of armour has been employed as the chief defensive material of the more important battleships built in this country and abroad. Thinner plates of chrome and nickel steel are also currently produced for lighter defences. The rolling mill now in use for armour plates was laid down in 1862, and has been in use ever since, the design having been such as to provide for the constantly-increasing dimensions required in the newer ships, though, of course, in the planing larger and more powerful tools have from time to time been provided to meet the altered requirements of the trade. In the large press shop, where the number of spectators was increased by the Southern contingents, the forging of a large ingot in its step towards conversion to a marine crank shaft was effected in the large 4000-ton hydraulic press, erected in 1887 from the designs of the late Mr. B. Walker. This forging is for one of the shafts of H.M.S. Hermione, now building at Clydebank.

The next items on the programme were the casting a large ingot from the Siemens' furnaces, and the working of the hot saw upon a hard steel-faced plate intended for the armour of a cruiser, for the Netherlands Government, the latter being among the most remarkably striking sights that can be witnessed at these works. After passing through the tire mills, a good example of the working of the Bessemer process was given in the blowing of a charge; which although somewhat slow, behaved in the most exemplary manner, and was cast into ingots for axles by the method of group casting, with a central feeding column. The large flanging press was next seen in action, flanging the lower half of a boiler front with the furnace holes. This magnificent machine will take a plate 20ft. by 10ft., and has flanged many thousand plates both in steel and iron.

The newer specialities of the works, the Purves ribbed furnace flues and the Servé tubes for marine boilers, were the last items on the programme; and by this time the period allotted for the visit had nearly come to an end, so that the inspection of these departments was necessarily somewhat less deliberately made than those that were seen earlier in the day. The construction of these tubes will be sufficiently familiar to our readers to make it necessary to describe them in detail here; but what is perhaps the most interesting novelty in connection with them is the range of experimental boilers for comparing the efficiency of these forms of tubes with those in use in ordinary marine boilers, which have been under trial for some time past. These consist of two pairs of boilers, 10ft. 6in. in diameter, one pair being fitted with Howden's system of forced draught, while the other is arranged for working with induced draught, by an exhausting fan in the uptake, upon Martin's principle. One boiler in each pair has plain brass tubes, while the other is fitted with Servé ribbed tubes and Howden's spiral diffuser, which latter contrivance is also used in the plain tubes. During the period of the visit a comparative trial was made upon two of these boilers, commencing at 10.30 a.m. and ending at 4 p.m., in which time an equal quantity of Yorkshire coal (about 65 cwt.) was burned in each, with the result that the effect obtained in the plain tube boiler was 7·38 lb. of water evaporated per lb. of coal, while in that with Servé tubes it was 8·46 lb., the effective steam supply being equal to 435-horse power in the former, and 490-horse power in the latter case.

Another modification in which greater economy is aimed at is the combination of the induced draught system with air heaters consisting of horizontal tubes open to the air, and heated by the waste flame on its way to the chimney, whereby an air supply at a temperature of 300 deg. Fah. is obtained in the fireplace. This, although leading to a considerable saving over the other systems of fitting, has the inconvenience of producing an intense local heat very trying to the fire-bars, so that a special system of air or water-cooled grate will be required before the full advantage can be realised. These extremely interesting experiments are, however, as yet in a very unfinished state, but we hope to have the opportunity of returning to them when more complete details shall be available. These boilers form part of a new steam-producing plant in a boiler-house at the western end of the works which is intended to hold twelve large marine boilers in substitution of numerous smaller ones distributed about the various departments which take up room that can be more usefully occupied, as each of the new boilers replaces three or four of the older ones.

After going through the works' programme the whole of the visitors were entertained at dinner by Messrs. John Brown and Co. at the Cutlers' Hall, the chairman—Mr. J. D. Ellis—presiding, and at 6.30 p.m. the party dispersed from the Midland Station to their homes, carrying with them the recollections of a visit of more than ordinary interest. The arrangements were admirable. Mr. Ellis, together with Captain Tresidder and other principal chiefs of departments, were present with the party during the day, and all information asked for was readily and freely given, and as a *souvenier* of the visit, a book containing a perspective view and general plan of the works, and plans of the three collieries belonging to the company, together with a short sketch of its development, was given to each of the guests.

HARBOURS AND WATERWAYS.

THE Mersey Dock Board some time since determined to make new deep-water entrances to the Canada, Huskisson, and adjoining docks. They have now gone a step further, and have decided to make the new locks both wider and deeper. The Committee reported that from inquiries made from the owners of the large Transatlantic liners they found that one company was providing steamers having 65ft. beam, and they were advised to prepare for vessels 700ft. long, although none so large as this were actually building at the present time. It was, therefore, decided to make the new locks 100ft. in width instead of 80ft., as originally intended, the sills to be laid 20ft. 6in. below the level of the Old Dock sill, or 18in. lower than originally determined, giving a depth of 12ft. at low-water spring tides and 40ft. at high water. The new graving dock, on the site of the Huskisson Dock, is to be made 700ft. long, with its entrance 90ft. wide, the sill being 10ft. below Old Dock sill level. The extra cost involved by these increases in the dimensions is estimated at £180,000, and it is expected that it will be four years before the work will be completed. The width of the proposed new locks will be 35ft. wider than the widest mercantile vessel which is now afloat or building. This seems a very large margin to allow, but it is contended by nautical men that if the entrance has not considerable margin in the width there will be difficulty in undocking vessels on a spring tide. All vessels cannot get out at high water, and with a run of tide past the entrance there will be risk of vessels of 700ft. in length swinging before they clear, and being caught on the side of the lock. The Board have also decided to obtain a larger dredger for the deepening of the bar of the Mersey, and to expend £65,000 in the purchase of a machine capable of carrying 3000 tons and raising 4000 tons an hour and reaching to a depth of 30ft. The depth over the bar has been so improved by the dredging already carried out that captains report soundings of 18ft. at dead low water of spring tides during the past three or four months. The Belfast steamers and other coasting vessels, which had formerly frequently to wait outside, are now able to cross the bar and enter the river at all states of the tide.

Two dredging contracts have lately been made, the particulars of which may be interesting, as showing the price at which this work can be done when the quantity of material to be moved is small. At Torquay, for dredging over an area of 79,869 square yards, which will give an increased depth in the harbour of about 6ft., eight tenders were received, that of Mr. Green, of Newport, for £5558, was accepted, the price to be paid for any excess or diminution of the work being 1s. 3d. per cubic yard. The material to be moved is principally sand, which is to be used in filling the ground at the back of the new embankment, and in raising the Tor Abbey sand. The time given for completing the work is five months. At Newport five tenders were sent in for removing a shoal of gravel and clay containing about 35,000 cubic yards, the lowest being £2800, or about 1s. 7d. per cubic yard.

The traffic returns of the Bristol Docks, including Portishead and Avonmouth, for the year ending the 30th of April last, show that the tonnage has been 699,923 tons, an increase of 60,423 tons on the previous year. The dues amounted to £96,403, an increase of £7165. A new line of steamers, the North Atlantic Trident Line, has commenced running between Philadelphia and Avonmouth; and shortly another line, the Manhasset, will commence running between Avonmouth and New York.

The Bill for transferring the Southampton Docks to the London and South-Western Railway Company has been passed; the price to be paid is £1,360,000. A clause has been inserted in the Bill to the effect that if a Public Trust be created within twenty-one years from the passing of the Act, the railway company shall hand over the docks to the Trust, upon terms to be settled by agreement or arbitration. It is understood that the company are prepared to spend a large sum of money in building a second dry dock, and in otherwise providing machinery and facilities for working the docks. The South-Western has already advanced £300,000 to the dock company, without which the new Empress Dock could not have been constructed. It is found impossible to raise the further money to develope the docks. This is the second instance this session in which a Parliamentary Committee has decided that it is to the interest of the public that an impecunious dock company should pass into the hands of a railway company. The effect of this has been in both cases to raise the value of the shares, which had fallen to about one-fourth of their original value.

The power to construct a dock on the East Coast, which had been obtained by an independent company, has also this session been transferred to the new East and West Coast Railway Company. The Bill promoted by the North-Eastern Railway Company for the purchase of the Hull Docks and the construction of a new dock, which had passed the Lords, was thrown out by the committee of the House of Commons.

The London and St. Katherine's Dock Company are seeking an amendment of the Act which was passed in 1888, which, if the Bill be passed, will enable them to raise £200,000 for the purpose of making a new entrance at Blackwall into the East and West India Docks. Although the docks in London received a considerable check owing to the strike of the labourers and the uncertainty as to the time in which vessels could be loaded and unloaded, trade begins to show signs of revival, and it was stated by the chairman at the meeting of shareholders called to approve the Bill now before Parliament that the traffic of the London Docks had increased from 1,700,000 tons twenty years ago to 3,200,000 tons at the end of last year, and that the dock authorities had to provide for an average increase of 100,000 tons a year. The works contemplated will enable the Old West India Docks, now practically idle, to accommodate vessels of the modern type. The joint companies had an increase of £105,000, or nearly 20 per cent., on their revenue last year.

The Bill promoted by the Manchester Ship Canal Company has been passed. The contention with the Upper Mersey Commissioners was settled by the insertion of a clause, by which it is provided that all vessels going by the canal to Ellesmere Port, Weston Point, and Runcorn Docks, and along the Weaver and Bridgewater navigation, are to pay the Upper Mersey dues; and the canal company are to guarantee the conservators a minimum revenue of £2800 a year. All other vessels, except to the places named, entering or leaving by the canal, are to be exempt from dues. The Bill further gives the company power to purchase additional land to the extent of 100 acres. A clause which had been inserted in the Bill for power to charge a toll on boats using the canal propelled by steam, in addition to the toll on the cargo, was not allowed. This clause was opposed by the Rochdale Canal Company, who carry a considerable amount of traffic on the canal by steam haulage. It was contended before the Committee that there had been spent £112,000 in adapting the canal for steam haulage, and that in consideration of this they ought to be allowed to charge an extra toll. The advantage of the canal to the salt trade has recently been shown by the loading in the Weaver Pool of a vessel of 550 tons of salt from Messrs. Verdin's works at Northwich. The steamer was loaded and proceeded on her voyage to Scotland in twenty-four hours after her arrival. As the tides at the time were neaps, she would have been detained several days if she had to proceed by the old course along the Upper Mersey. An Italian barque, laden with grain from the River Plate, has also been discharged in the Weaver Pool. Two other vessels from the River Plate have also been discharged at Ellesmere Port.

The Board of Trade inquiry into the canal rates, tolls, and charges, has been proceeding in London. The Aire and Calder Canal; the Leeds and Liverpool; the Birmingham; the Grand Junction; and the Warwick and Birmingham Canals have been taken as typical of all other canals, and the petitions against the classification of merchandise and schedules of maximum tolls and charges proposed by these companies are being first proceeded with. The traders have raised objection to the proposed terminal charges, and claim the right to enter the premises of the companies to load and unload goods carried in the companies' boats. They also raise objection to the proposed charge for empty boats lying in the canal.

The Commissioners of Northern Lighthouses have determined to lay down a number of gas buoys in the Firth of Forth, in substitution of the existing buoys.

The question of draining the Zuyder Zee, which has been in agitation for a long time past, has again been revived by a report issued by a Commission which had been appointed to investigate the subject. The Commission in its report recommends that the Zuyder Zee should be cut off from the North Sea as far as, and including, the island of Wieringen. The cost is estimated at about £15,000,000; the time for completing the work is put at thirty-two years.

The increase in traffic on the Suez Canal for the year 1891 amounted to 1,807,268 tons. The chief items of increase are from corn, linseed and similar grain, and rice. Meat from Australia has become a very important article of transport, the number of carcasses amounting to 60,000 a month. The dividend to be paid, after providing for sinking fund, is 20 per cent. This country is not only the largest shareholder in the canal but also the largest customer. No less than 76 per cent. of the vessels and 78 per cent. of the net tonnage passing through the canal belonged to this country, 7 per cent. belonged to Germany, and 4 per cent. to France. The average size of the vessels continues to increase, being this year 2067 net tons, as against 2033 in 1890. Ten years ago the average was only 1517 tons. For the first three years after the opening of the canal it was only 988 tons. The average time taken for vessels to pass through the canal was 23½ hours, which is an increase in speed of about half an hour on last year's average rate.

A case of some importance to those employed in dredging operations was recently decided in the Admiralty Court. A hopper barge was being towed down the Tees by a tug. A steamer laden with iron ore was coming up the river, the tide being at half-ebb. When within about a quarter of a mile of each other, it became apparent that a collision was inevitable. The steamer backed her engines and tried to get out of the way; but the tug running with a strong ebb had no control over the hopper, so far as stopping her, and to save herself cut off the tow rope from the hopper. The steamer and the hopper came in collision. The hopper was holed, and sank with her load. The steamer had to be beached to prevent her from foundering; the tug escaped without damage. The owner of the steamer sued the owners of the tug and of the hopper barge for damages. The owner of the hopper barge counterclaimed against the owners of the steamer. The Court held that the tug was solely to blame, on the ground of its having been settled that barges in tow were considered to be under the control of the tug. Where the master of a tug has to obey the commands of a pilot or captain of a vessel, and damage results, the tug is absolved. The owners of the barge pleaded that when abandoned by the tug she had her helm hard-aport, in consequence of smelling the ground on the south shore, and hence the collision. It was also contended that no serious damage would have been done if the anchor of the steamer had not been hanging from her port bow, with the flukes a little below the surface and projecting. This plea of contributory negligence was not allowed, as it was not shown that there is any bye-law on the Tees to regulate the anchor being partially awash.

OPENING OF PRESTON DOCKS.

ON Saturday last the new dock at Preston was formally opened by H.R.H. the Duke of Edinburgh. The foundation to this dock was laid by H.R.H. the Prince of Wales in 1885. The area of the dock is forty acres, the space being unbroken by projecting piers. There is also a tidal basin of 4¾ acres, the water in which is held up by a pair of tidal gates.

The dock is connected with the London and North-Western and the Lancashire and Yorkshire Railway Company's main lines. There is a large area of land round the dock suitable for quays and storage. The new river diversion runs parallel with the south side of the dock, and has been provided with quay walls and berths for small vessels not requiring to enter the dock. The whole appears to have been well designed, and the work is sound and of excellent quality.

The dock has been constructed by the Corporation of Preston, the money being raised on the security of the rates of the town. The contract for the dock, tidal basin, and river diversion was taken by the late Mr. T. A. Walker for £456,600, and it has been completed by his trustees under the direction of Mr. Knott. The engineers are Messrs. Garlick and Sykes, Mr. Sykes having the entire charge of the work during the latter part of the time, Mr. Garlick being obliged to retire from ill-health. Mr. T. G. Lumb and Mr. Robert Sykes have acted as resident engineers. The tidal basin is 850ft. long and 300ft. wide. It is connected with the dock by a lock 550ft. long and 66ft. wide, divided by intermediate gates into two compartments, one 325ft. and the other 225ft. long. The lock sill is 38ft. below the coping level, giving 29ft. of water at ordinary spring tides. The length of the dock is 3020ft. and width 600ft., giving a quayage of 2266 lineal yards. The whole of the walls are of concrete of very excellent quality. They are 40ft. high, 17ft. 6in. thick at the bottom, diminishing to 10ft. at quay level, battering on the face ½in. to 1ft., and stepped at the back. Vertical rubble drains were put behind the walls every 60ft., with 4in. iron pipes through the walls, which were plugged up before the water was let in. The excavations amounted to 4,000,000 cubic yards of earth, sand, and gravel, and 1,000,000 yards of rock. The walls contain 255,760 yards of concrete. The explosive used on the works for blasting the rock has been principally tonite. The holes for the blasting averaged 12ft. deep, and required two men three hours each to drill them. Sixteen to twenty piles and primers were required in each 12ft. hole to loosen and shake the rock, 4 oz. of explosive being used in each pile. The total amount used was 227,240 lb.

The walls are all coped with granite, and a hydraulic pipe trench and chamber is formed in them, and extends round the whole of the dock, lock, and tidal basin, with manholes every twenty yards. The trench is of sufficient size to carry the gas and water pipes. The foundation of the walls and the floor of the lock rests on red sandstone rock. The best of the rock excavated has been used for the training walls. A sufficient quantity of sand and shingle was obtained in the excavation to provide the material for the concrete, which consumed over 30,000 tons of Portland cement obtained principally from the West Kent Cement Company. The gates are built of greenheart, each pair weighing 260 tons, and are opened and closed by hydraulic power. The engine-house and accumulator is placed at the lower end of the dock near the lock. The buildings are of red brick, with terra-cotta mouldings. The chimney is 156ft. high. Steam is provided by two steel boilers made by Messrs. Foster and Sons, of Preston, 24ft. long, 7ft. diameter, and designed to work at a pressure of 100 lb. per square inch.

The pumping engines are a pair of horizontal compound-condensing engines of the tandem type, so arranged that each engine can be worked separately. The accumulator has a ram 17in. diameter and 17ft. stroke, and is loaded to give a pressure of 750 lb. to the inch. The coal tips, cranes, and other hydraulic apparatus are not yet fixed, the Act giving the necessary powers for raising the money for this and other equipment having only been passed this session. The total cost of the works, including the dock, river diversion, dredging the channel, Parliamentary and other expenses, will be over a million.

A great deal of work yet remains to be done before the channel of the river will be brought to the intended depth. The present improved condition of the channel admits of steamers drawing 16ft. getting into the dock, and already a fair coasting trade is being developed; several of these steamers entered the dock on the opening day. Considering that Preston is in the heart of Lancashire, and is situate in the midst of one of the most thickly populated parts of the country, that it has within a very few miles access to the coalfields of Wigan, there can be no doubt that when a good navigable way from the sea is provided a large shipping trade will spring up.

The Corporation possess three very powerful dredgers, constructed for them by Messrs. Fleming, Ferguson, and Co., and a fleet of hopper barges; but only one of these dredgers is at present employed on the river, the other two having been let to the Manchester Ship Canal Company. If the trade of the dock is to be developed, these dredgers should at once be brought back and set to work to deepen the channel, as it is evidently of vital importance that a sufficient depth of water should be provided for ocean-going steamers. The training wall on the north side has been carried down nearly to Lytham; but further work yet remains to be done in completing this and also the wall on the south side, which extends to the tenth mile below the dock.

RAILWAY MATTERS.

MESSRS. MERRYWEATHER AND SONS have just completed a contract for additional steam tramway locomotives for the Dutch State railways. The engines are similar to those supplied in 1880, having 7in. cylinders and a stroke of 11in. Thus, notwithstanding the increasing competition of the last twelve years, repeat orders are still being given to English makers.

THE Paris correspondent of the *Times* says:—The Paris and Lyons Railway Company, after a six weeks' trial, has resolved on adopting the idea of M. Edouard Cros, viz., that every carriage should have on the outside a distinctive sign, such as an animal or plant, so that passengers may easily find the carriage they have quitted. This sign will be in white enamel on a blue ground, so as to be prominent by night as well as by day. The number of a carriage notoriously fails to impress itself on the memory, and hence the scenes of confusion when passengers hurry back to their carriages after a stoppage for refreshments.

A LANDSLIP, involving serious loss of life, occurred between the Monte Sasso and Marzabotto stations on the Bologna-Florence Railway, which passes through the Apennines, on the 24th ult. The driver's attention had been arrested by a strange rumbling noise, which increased into a terrific roar, and he stopped the train in time to prevent it entering the length of line on which huge masses of earth and rock were crashing from the mountain side. A whole slice of the mountain broke away from the main body and precipitated itself into the valley beneath. Houses were swept away by the landslip inhabited by thirty-four persons, all of whom were of the poorer class, and several were killed.

WE learn that the experiments undertaken by Messrs. Easton and Anderson, in conjunction with Mr. M. Holroyd Smith, on behalf of the Bradford Corporation, to demonstrate the efficiency of electric energy in propelling tramcars up steep hills, have been brought to a successful conclusion, and arrangements are now being made for the construction and equipment of two miles of line where the average rise in the total length is 1 in 24, the road in many places being as steep as 1 in 13·3. The Corporation has consented to allow the temporary overhead conductors used for the demonstration, to remain in position for another fortnight, in order that gentlemen from other towns, interested in tramways, may witness the running of the car. Should any of our readers desire to personally inspect the tram car and its working, they may, on application to the London office of Messrs. Easton and Anderson, 3, Whitehall-place, be furnished with the necessary permits for so doing.

THE British Consul at Jerusalem, in his last report, refers to the progress of the Palestine railway, which has now been in course of construction for the last two years. The concession was granted by the Porte in 1888 to a company styled "Société Anonyme Ottomane," having its headquarters at Paris, and the works, which were calculated to cost about £240,000, but which will probably exceed that sum, are being carried out by a firm of French engineers. A little over one-half of the line has now been constructed, and there is a prospect that the remainder will be completed in September or October next. The line from Jaffa to the foot of the mountains, says the *Times*, is in a fairly good condition, but it has not yet been opened to traffic. The part to be finished is that which lies between the Jaffa plain and Jerusalem, and which will follow one of the valleys leading up towards Jerusalem from the south-west. The work will be difficult, but it offers no insurmountable obstacles. The length of the whole line will be fifty-four miles, or seventeen miles longer than the present carriage road. When the line is completed a branch will be made from Ramleh to Gaza, possibly with the object of forming a junction with a line from Egypt.

A STATION accident, which fortunately was attended with no very serious results, occurred in May on the London and South-Western Railway, at Southampton station. It is a curious case, as showing how accidents may occur with the most careful attention to regulations. It appears from the evidence that the driver entered the station at a moderate rate of speed, and that he was relying on the hand-brake and not on the continuous brake to pull up the train. The latter was, in fact, moving so slowly that an inspector, who thought that it would stop too soon and foul the points leading into the carriage sidings, gave the driver a hand signal to draw the train further down the platform. The fireman thereupon released the hand-brake, and let the train run down until it was about a coach-length from a bogie carriage, standing by the buffer stops. He then re-applied the hand-brake, but the rails being wet and greasy, the wheels of the engine skidded and slid along the rails. The driver immediately applied his vacuum brake, which acted properly; but the distance was so short that before the train was stopped it struck the bogie carriage. The shock was slight, and probably had the passengers not been standing up ready to alight, they would have received no injury.

THE Nunhead and Shortlands Railway, having passed the Board of Trade inspection, will be opened to-day. This line, to be known as the Catford branch, leaving Nunhead, runs for a few hundred yards parallel with the Crystal Palace section, and then bears away eastward. There are two important brick arches spanning existing or proposed roads on this short section, and a heavy piece of iron bridge work to cross the Brighton Company's line at Brockley. Beyond this bridge is a clay cutting. From New Cross to Forest Hill a stretch of level country is passed, and an iron bridge crosses the Ravensbourne. There are on the line five stations, which will be called Crofton Park, Catford, Bellingham, Beckenham Hill, and Ravensbourne, and all are built of red brick with red tiles, and in a style likely to harmonise with the villas which will spring up around them. The platforms are 450ft. long by 15ft., and for 120ft. are covered by a glass verandah. Galleries are provided for passengers crossing the metals. The Ravensbourne and Catford Stations, being on a high level, arrangements have been made for lifts for passengers' luggage. Messrs. Saxby and Farmer have carried out the signalling work, whilst the telegraph system has been arranged by Mr. F. Rudall, and included under this head is Sykes's well-known system of electrical signalling and inter-locking, which is in use on the whole of the London, Chatham, and Dover Railway, fitted under the personal supervision of the inventor.

AN important letter on the Mombasa and Victoria Nyanza Railway has been forwarded by the British and Foreign Anti-slavery Society to all candidates seeking election to the next Parliament, without distinction of party. It encloses papers "in support of the proposed railway from Mombasa to Victoria Nyanza, without which it is practically impossible to bring the great and populous region of Uganda into touch with British interests. This scheme, if carried into effect, cannot fail to assist most materially in the suppression of slave traffic, and in the abolition of the status of slavery in the territories brought under the influence of the proposed railway; and, if for this reason only, it is deserving of the cordial support of every individual. But, apart from these considerations, the scheme must recommend itself to all those who are interested in extending the commerce of this country. The great national interests involved in and around Uganda render it desirable that public interest and attention should be attracted to the important events now passing in Eastern and Equatorial Africa, which offer to this country the dominating position over the vast territories commanding the sources of the Nile. But should the British public now hesitate to act with firmness and promptitude, doubtless other nations, who are waiting for our faltering, would take the opportunity to step in and occupy a position which would not only prove detrimental to the Imperial interests of this country, but would inevitably prolong the horrors of the slave trade.

NOTES AND MEMORANDA.

SPLENDID specimens of mica are to be sent to the Chicago Exhibition from Idaho, where the supply is said to be practically inexhaustible. Mica is to be used in the Idaho building as a substitute for glass in the windows.

THE mean organic carbon in the Thames water supplied to London during May reached only 0·119 of one part in one hundred thousand parts, and the maximum in the past three months corresponded to but about $\frac{3}{10}$ths of one grain in 70,000 grains, or 1 lb. in about 1000 tons.

THE deaths registered last week in thirty-three great towns in England and Wales corresponded to an annual rate of 17·3 per 1000 of their aggregate population, which is estimated at 10,188,449 persons in the middle of this year. Croydon was phenomenally best with only 8·8, and Oldham worst with 22·9.

IN London 2654 births and 1415 deaths were registered. The births were thirty-five, and the deaths eighteen, above the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes was 17·3 last week, and during the last four weeks the death-rate averaged 17·3 per 1000, being 0·6 per 1000 below the mean rate in the corresponding periods of the ten years 1882-91.

ACCORDING to the report of Mr. W. J. Dibdin, F.C.S., on gas supplied to London during week ending 11th June, there was one occasion on which the illuminating power of the gas was below the standard, viz., on the 9th June at St. George's-in-the-East, 15·5-candles. The tests for sulphur at the Clapham testing station gave on three days 18·26 grains per 100 cubic feet of gas; at Peckham the average reached 18·46; and on three other days, 19·56 grains per 100 cubic feet.

AT a meeting of the Paris Academy of Sciences on May 16th, a paper was read on the determination of the density of liquefied gases and their saturated vapours; elements of the critical point of carbonic acid, by M. E. H. Amagat. The critical constants for carbonic acid are given as—temp. = 31°·35 C., pressure = 72·9 atmos., density = 0·464.—Observation of the partial eclipse of the moon on May 11-12, 1892, by MM. Codde, Guérin, Nègre, Zielke, Valette, and Léotard, and on the theory of *fonctions fuchsiennes*, by M. L. Schlesinger.

FROM the census taken last April of the ten French towns which had over 100,000 inhabitants, it appears that the increase since the previous census has not been very marked, except at St. Etienne, Marseilles, and Lille, while at Nantes there has been an actual decrease. The greatest increase has been in towns with under 100,000 inhabitants, such as St. Nazaire, the port of Nantes, which has increased by 65 per cent.—from 15,900 to 41,000; while next come Nice, where there has been an increase of 27 per cent.—from 75,959 to 96,284; Montpellier, where the population has increased from 57,231 to 69,831, or 22 per cent.; and Grenoble, where there has been an increase of 20 per cent.—from 50,677 to 60,698.

IN a note on "Use of Compressed Oxygen in the Calorimetric Bomb" (*Comptes Rendus*) M. Berthelot says if the oxygen used has been kept in a gas-holder over water, it is saturated with aqueous vapour, and when compressed in the bomb sufficient water is condensed to again saturate the gas at the end of the experiment. The difference in the tension of the aqueous vapour resulting from the difference between the initial and final temperatures—usually about 3 deg.—would introduce an error of less than half a minor calorie, which is negligible in all ordinary cases. If, on the other hand, commercial compressed oxygen is used, the gas is practically dry. It follows that in most cases some of the water produced by the combination will evaporate in order to saturate the gas in the bomb. The absorption of heat from this cause will amount to from 2 to 3·5 cal. in a bomb of about 330 c.c. capacity, and to 5 or 6 cal. in a bomb of 600 to 700 c.c. capacity.

THE American papers are giving accounts of an interesting water-power plant recently made by the Pelton Water-wheel Company, in one of the Comstock mines at Virginia City, Nevada. The wheel, which is 36in. in diameter, is made of a solid steel disc with buckets rivetted to its periphery, and weighs only 180 lb. It is driven by a vertical column of water with a head of 2100ft., which is equal to a pressure of 911 lb. Of this head 460ft. is obtained from the Gold Hill Water Company, and the remaining 1640ft. from the shaft of the mine down which the pipe line is run to the Sutro Tunnel level, where the power station is located. The wheel is supplied with two $\frac{3}{4}$in. jets, runs at 1150 revolutions, and develops 100-horse power. The same company two years ago erected a similar wheel in the Chollar shaft on the Comstock lode. This consisted of six 40in. Pelton wheels, running under a vertical head of 1680ft., and driving six Brush generators. These wheels weigh 220 lb. each, and with nozzle tips $\frac{3}{16}$in. in diameter develope 125-horse power. They are directly connected to the dynamo shaft.

NUMEROUS bacteriological examinations, during a number of years, of the Zürich water supply, before and after filtration through sand, have led to certain conclusions which may be summarised as follows:—Fränkel and Piefke's assertion that sand filters offer no absolute protection against pathogenic organisms is disputed, as being not applicable to all sand filters; and their statement that the number of bacteria present in the filtered water is simply proportionate to the rate of filtration and to the number of organisms existing in the water originally, is shown to be erroneous. On the contrary, the author finds that under the conditions obtaining at Zürich, the number of developable spores in the filtered water is small and fairly constant, and quite independent of the degree of original pollution or the rapidity of filtration—3m. to 12m. per day. It is of importance, however, that the filters be allowed time to acquire their normal working condition, and that the rate of filtration be uniform. In the case of new filters, or after cleaning, &c., the action is for some time abnormal, and the water during filtration may even take up organisms from the sand.

IN a paper on "The Heat of Combustion of Coal, Determined by Means of a Calorimetric Shell," MM. Scheurer-Kestner and Meunier-Dollfus (*Bull. Soc. Ind. Mulhouse*), describe some experiments which they carried out with the object of verifying results obtained by them with a Favre and Silbermann calorimeter. The apparatus used was Berthelot's calorimetric bomb, which was placed at their disposal. This consists of a metal shell lined with platinum (to resist chemical action), in which combustion can take place, and an ordinary calorimeter of about 2 litres capacity in which the shell can be suspended, and by means of which the heat developed is observed. The substance to be experimented upon is weighed and suspended within the shell in a perforated platinum capsule. Immediately above this is placed a spiral or fine iron wire, through which a current of electricity can be passed. The lid of the shell, which can be screwed in its place, carries a valve, by means of which oxygen at a pressure of 25 kilos. can be admitted to the interior. This having been done the shell is placed in the calorimeter, and the temperature of the whole is allowed to become uniform. The temperature is then observed from minute to minute and a current is sent through the spiral. This, as it heats, sets the combustible on fire. Combustion is sudden and complete, leaving no combustible residue. The temperature should be observed during several minutes, but the whole operation is over in a quarter of an hour. The authors consider that they have proved (in conformity with their earlier researches) that some kinds of coal have a heat of combustion which is greater than that of the carbon and hydrogen which they contain; the heat of combustion of others is less than this, although it is sometimes higher than the heat calculated by Dulong's method.

MISCELLANEA.

MR. THOMAS TURNER, of Stourbridge, has been appointed manager of the iron and steel works of the Shelton Iron, Steel, and Coal Company, Limited, Stoke-on-Trent.

FIVE square miles of land adjacent to Dauphin, a village close to Chicago, have been suddenly flooded, and a thousand houses between State-street and Lake Michigan are inundated through the bursting of a dam in consequence of recent heavy rains.

A TERRIBLE accident took place at Fettykil Paper Works, near Leslie, Fife, on the 27th ult. A bridge is being constructed over the river Leven, and a portion which was finished last week collapsed while the centre piece and scaffolds were being taken down. About twelve yards gave way, carrying the workmen down into the water. Five men were drowned, including Mr. Gold, the foreman.

HIS Highness the Khedive of Egypt has conferred on Mr. James Hornsby, J.P., D.L., the distinction of Commander of the Imperial order of the Medjidieh, in recognition of valuable assistance given to agriculture in connection with the Tewfikieh College of Agriculture. The handsome star of the order has been received through Mr. Alfred B. Brewster, English secretary to H.H. the Khedive at the Ras-el-Tin Palace, Alexandria.

IT is stated that notices have been issued to the engineers employed on the Tyne and Wear for a reduction of wages of 10 per cent., 7½ per cent., and 5 per cent., on different classes of work. By this from 15,000 to 20,000 men are affected. The notice applies to all branches of the engineering trade, including fitters, erectors, millwrights, planers, holders-up, screwers, brass-finishers, joiners, smiths, plumbers, strikers, platers, rivetters, slotters, flangers, and the members of the Boilermakers' and Iron Shipbuilders' Society engaged in engine-shops.

THE annual conversazione of the Society of Arts took place on Wednesday evening at South Kensington Museum, and was largely attended. In the absence of the Attorney-General, the chairman of the Society, the guests were received by Sir Philip Cunliffe Owen, and the members of the council. The whole of the courts and corridors of the ground-floors were open, together with the galleries containing the Raphael cartoons, the Sheepshanks collection, and the William Smith collection of water-colour drawings, the Dyce and Forster pictures, and the Chantrey Bequest.

THE Thunderer, battleship, which has had her leaky boiler tubes completely ferruled, concluded her steam trials at Portsmouth on the 25th ult. by a four hours' run under forced draught. The trial was in every respect satisfactory, the ferrules having answered their purpose thoroughly. The average pressure of steam in the boilers was 137 lb., the vacuum 28in. and 27in., and the mean revolutions ninety-four to ninety-seven. The starboard engine indicated 3522 and the port engine 3544 horses, thereby giving a collective horse-power of 7066—or 66 beyond the specified contract—with 1·96in. of air pressure.

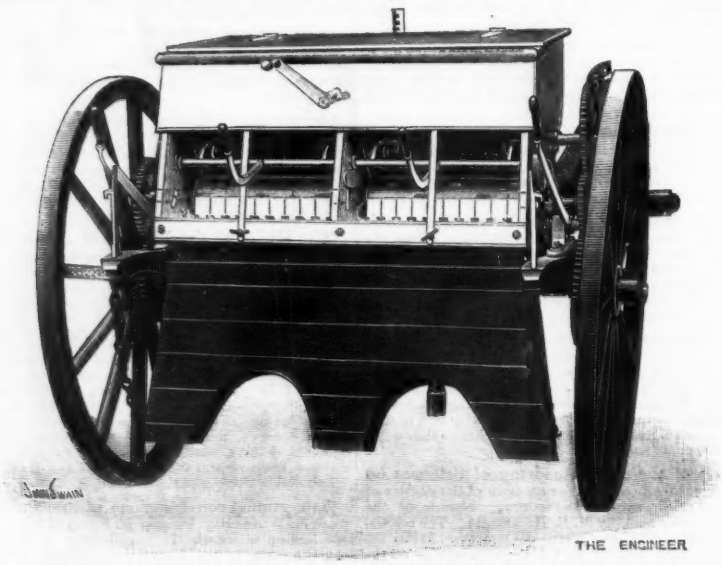
AN International Exhibition of Building Materials will be held at Lemberg under the auspices of the Governor of Galicia, from the 30th August to the 20th September, 1892. It will comprise all the materials falling within the province of the architect, including stone, bricks, marble, cement, lime, timber and iron, locksmith's work, and other manufactured goods, metals and ironmongery, asphalt, waterproofs, paints, lacquers, varnish, paper hangings, tapestry, water supplies, pumps, ventilators, lighting materials, sewers, lifts, arrangements for the extinction of fire, house telegraphs, telephones, special arrangements chiefly of a hygienic nature, oilcloth, carpets. A special jury will allot State medals to the exhibitors which will be placed at the disposal of the committee by the Austro-Hungarian Government. Information may be obtained from Mr. Arthur Gobiet, at Prague, Karolinenthal.

THE Yorkshire miners have been demonstrating at Wakefield. The day fixed for the gathering was St. Monday—a very popular saint in these parts, as employers know when a favourite fixture in football or cricket is "on" up there. Fifty thousand miners and their wives foregathered in the famous old cathedral city, for ever associated with Oliver Goldsmith and the gross of green spectacles. One hundred and twelve bands were present, and there was undoubtedly a powerful presentment of mining strength. The leaders of the Yorkshire Miners' Association were there, and in triumphant mood—as they had a right to be. It was reported by the secretary that during the last quarter their income, as members of the Association, had been at the rate of about £60,000 a-year. The actual amount for the quarter had been £16,688. For men out of work they had only paid £420. Since last demonstration they had invested £41,103. Since last year they had invested £81,301, making the total amount invested £122,404; or, including their property, the financial worth of the Association was £131,967. They had sent to aid their Northern brethren £17,979, of which £12,250 had gone to Durham and £5729 to Cumberland.

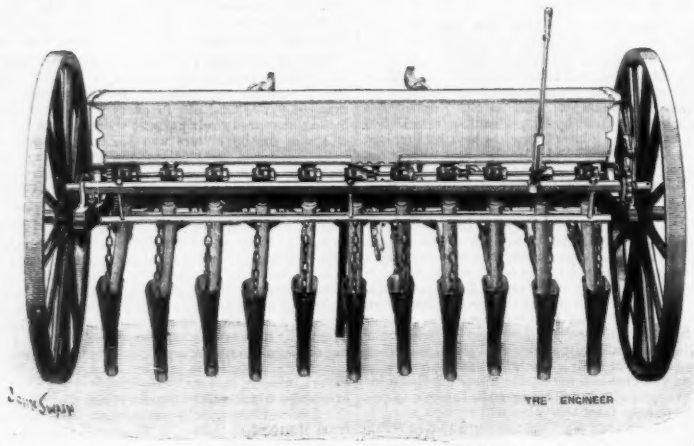
AT the sitting of the Commission on the Metropolitan water supply on Monday, Sir Thomas Farrer referred to one fact which had been elicited during the sittings of the committee but which had not been patent before, and that was the enormous demand that would be made by the surrounding counties for the water which had before formed part of the supply of London, and if it should happen that London had to supply the whole of the surrounding districts there would be also a demand on them for the supply of the populations of those counties, and, consequently, their demand would have to be taken into consideration as well as the demand for London proper. "He wished to confirm, from his own personal knowledge, the account which the Thames Conservancy had given of the origin of their jurisdiction over the water of the Thames. It was true that the upper Thames navigation had been in a state of absolute insolvency, and that, when Mr. Milner Gibson was President of the Board of Trade, there was extreme difficulty in ascertaining what should be done with the upper Thamas navigation, and the Thames Conservancy reluctantly, but at the desire of the Government, dealt with the matter, and, being a wealthy body and having at their disposal the funds arising from the navigation of the lower Thames, they made the lower Thames help the upper Thames. The upper Thames had always been 'out at elbows.'"

THE Home Secretary has sent the following notice to the Lord Mayor, calling attention to certain requirements of the Factory and Workshops Acts, 1878-91, with an intimation that the Home Secretary thought it of great importance, in the interests of all classes affected by the Act, that such notice, which sets out briefly the requirements of the law, should receive the widest publicity. The notice is as follows:—"Every person shall, within one month after he begins to occupy a factory or workshop, serve on an inspector a written notice containing the name of the factory or workshop, the place where it is situate, the address to which he desires his letters to be addressed, the nature of the work, the nature and amount of the moving power therein, and the name of the firm under which the business of the factory or workshop is to be carried on, and in default shall be liable to a fine not exceeding £5. All complaints with respect to danger from fire to factories, or with respect to the sanitary condition or overcrowding of workshops, to be made to the sanitary authority for the district. All complaints with respect to overwork or dangerous machinery or processes in factories or workshops, or with respect to overcrowding, bad ventilation, or the sanitary condition of factories, to be made to her Majesty's inspector for the district, or to Mr. F. H. Whymper, her Majesty's Chief Inspector of Factories, Home-office, London, S.W. Any complaints sent to her Majesty's inspectors of factories will be considered confidential."

IMPLEMENTS AT THE ROYAL AGRICULTURAL SHOW, WARWICK



COULTA'S THREE ROW RIDGE MANURE DRILL



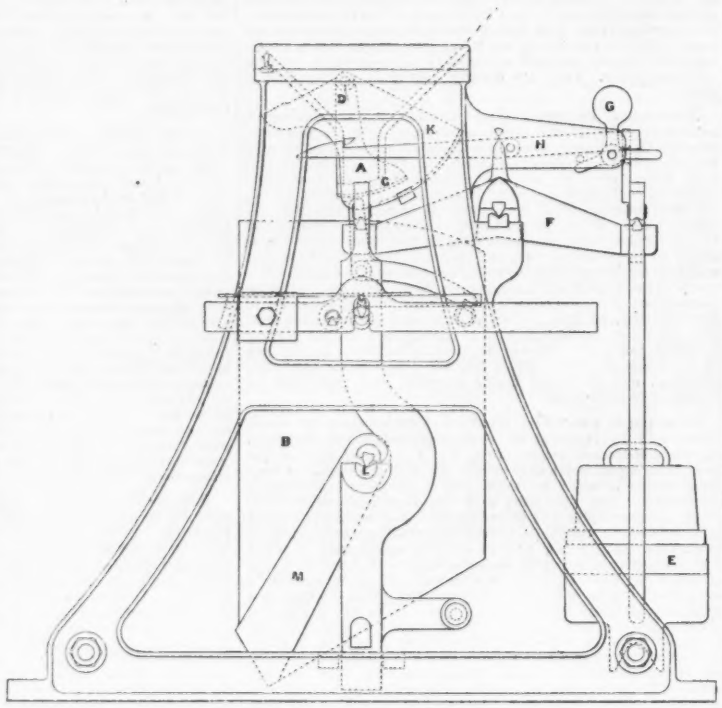
COULTA'S POSITIVE FEED CORN DRILL

THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

In our last impression we stated that Messrs. Aveling and Porter, of Rochester, exhibited at Warwick a new compound road locomotive. This is called by the maker a general purpose engine, and classed in their catalogue as 8-horse power. Seeing, however, that the engine will indicate 50-horse power with ease, the title does not mean much. This engine we now illustrate on page 9. It has been designed and constructed with all that minute attention to detail, resulting from a very extended experience, for which the firm possesses so high a reputation. The driving wheels are large, being 6ft. 6in. in diameter, and 16in. wide on the face. The leading wheels are 4ft. high and 9in. wide. The two cylinders are placed side by side, and the crank shaft is carried by the side plate box, which was introduced by Messrs. Aveling and Porter many years ago, and has given admirable results. All the gearing is of crucible cast steel, and is located between the side frame plates, hollow bosses containing the driving pinions. There are no sliding feathers to get loose. The boiler pressure is 140 lb., and the boiler was tested by hydraulic pressure to 280 lb. The engine is provided with the usual winding drum and wire rope. It is in all respects an excellent piece of work.

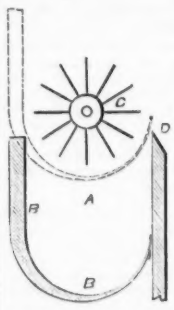
Messrs. Aveling and Porter exhibited an improved road roller, one excellent feature in which is the scraper, which we illustrate. The scraper is urged forward by a spring in a box, and it turns on a centre, its action being controlled by the same spring in a way which will be readily understood from the annexed sketch. There is thus obtained an elastic action which is very effective. The scrapers are maintained in or nearly in contact with the wheels, and cannot be caused to jump away and leave the gravel and stones on the wheel.

Mr. James Coultas exhibited the broadcast manure distributor for which he was awarded the Society's silver medal at Doncaster last year. This is a very simple machine, and may be understood by the accompanying sketch section. In the hopper A is an interior part B,

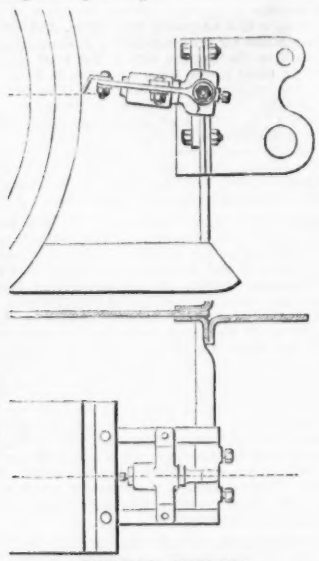


SIMONS' AUTOMATIC GRAIN SCALE

which may be in the position shown, or may be gradually lifted so that the curved bottom of it nearly touches the light tines of the roller C. Thus when the hopper is in its lowest position as shown, and is filled with manure, the tines of B slowly rotating constantly push an adjustable quantity over the lip D. The part B is gradually raised by worm and wheel gear as the manure is distributed. The same manufacturer exhibits the drill illustrated by the accompanying engraving. This drill is arranged to distribute any kind of manure down the ridge, more especially for potatoes, the manure drill following the potato planter. The same machine may be used in case of potato disease. It is 4ft. 8in. in width, and is fitted with gear of the Chambers type. The positive feed corn drill, as illustrated by the lower engraving, is on the Hosier system, is fitted with a very neat arrangement of Coulter lifting gear, an automatic arrangement for taking in and out of gear, and a simple form of spring relief coulter. It is also arranged so that the alternate coulters may be made to lead by any desirable distance, according to soil and cover required.



By the annexed engravings we illustrate the self-acting grain-weighing machine exhibited at work by the Trent Gas Engine Company, Nottingham. We give a perspective view of a medium-size machine, and an outline view, showing detail, of a machine for weighing ninety tons per hour. In these machines



AVELING'S SCRAPER

the grain or other material to be weighed enters at the top of machine through the port A, and falls straight into the receiver B, which gradually descends until nearly the full amount has entered, when a flap or valve C, pivotted at point D, falls across the port, cutting off supply of grain, which now runs slowly through two small holes in bottom of the flap (taking the place of

SIMONS' AUTOMATIC GRAIN SCALE

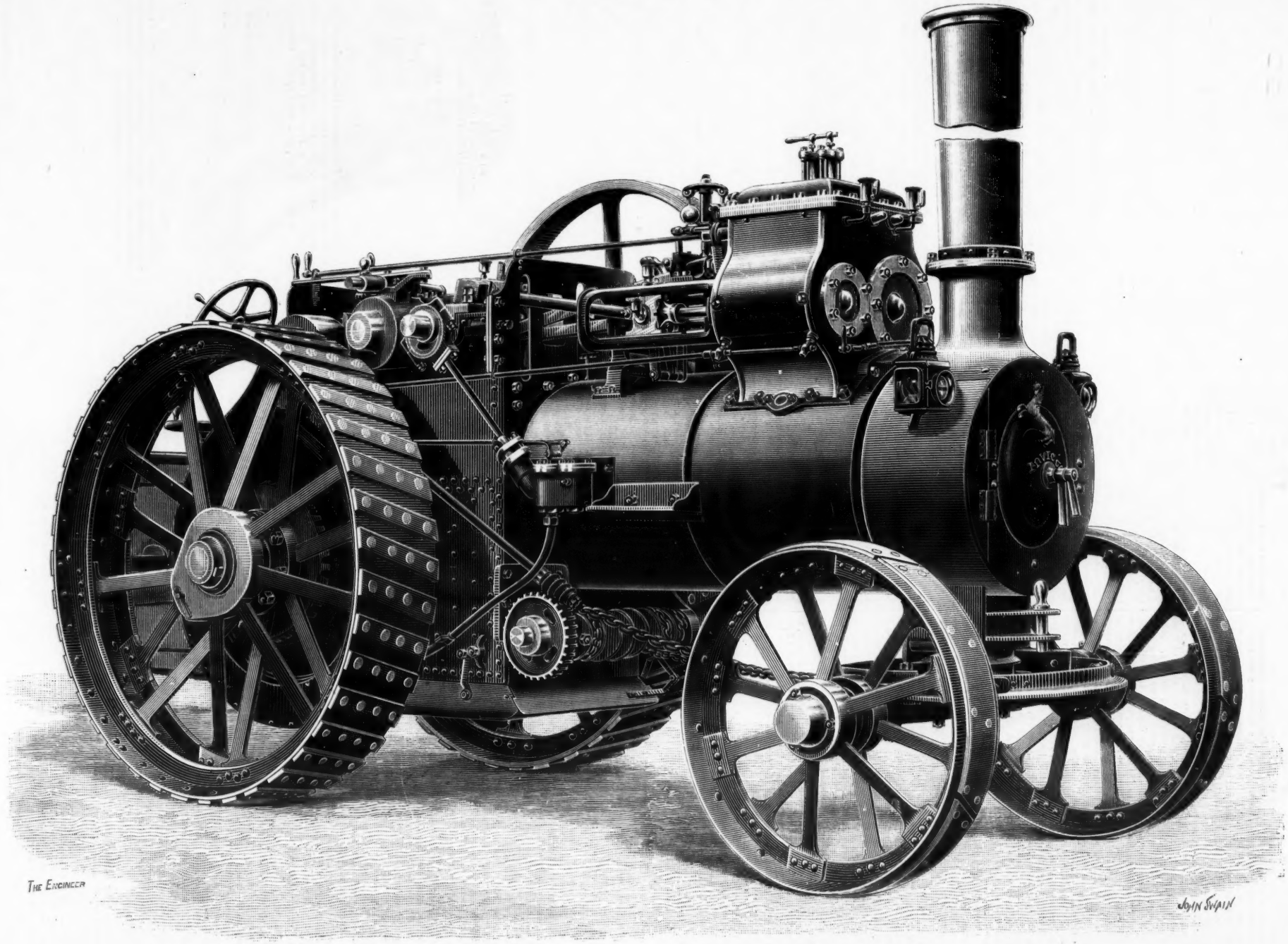
sprinkling by hand). The receiver still descending lifts the weight scale E on the other arm of beam F, and just as the right quantity of grain has entered, strikes the arm of the tumbling weight G, which in its fall pushes up the notched lever H, and allows a second flap K to fall and entirely shut off supply. This flap in its fall unhooks the receiver, which is pivotted at L on knife edges—a little out of the centre of gravity—and allowing it to tilt forward, in doing which it leaves the flap M behind, thus opening the discharge port through which grain pours out. As it is discharging the weight scale drops back, lifting receiver up again, when it turns back on the knife edges, closing the discharge flap M and opening the inlet flaps C and K on its way. The grain then enters again, and a fresh weighing commences. These machines are stamped as weighing accurately by the Board of Trade under the Weights and Measures Act, and the margin of error is almost imperceptible, or about one four-thousandth, whereas the margin of error in measuring by hand is 13 per cent., and of weighing by hand it is about 6 per cent. The machine weighs and keeps a counter record of the quantity weighed.

(*To be continued.*)

THE ROYAL AGRICULTURAL SOCIETY'S SHOW, WARWICK.—COMPOUND ROAD LOCOMOTIVE

MESSRS. AVELING AND PORTER, ROCHESTER, ENGINEERS

(*For description see page* 8)



LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

AERIAL NAVIGATION.

SIR,—I have read with very great interest Mr. Bernays' letter on the above subject, published in THE ENGINEER of the 17th instant. The theory that the wing feathers assist very considerably the flight of a bird, at first sight seems conclusively proved by Mr. Bernays' reasoning, and if birds were the only creatures that had th opower of flight, one would be justified in directing his mind to the designing of a machine which should as closely as possible imitate the involuntary action of the feathers, simultaneously with the voluntary action of the wing as a whole. But we have not only the smaller flying insects with comparatively small wings moving at a humming speed, and the butterflies with more slowly moving wings, very large in proportion to the weight carried, but many of the moths and flying beetles have bodies which are by no means small as compared to the wings, and the first class of these at any rate do not move their wings at a very high velocity. Most moths are covered with a light down; whether this assists their flight at all would be a question somewhat difficult to investigate. Probably not much, however, as the insect apparently flies just as well after some of these have been removed by the finger as before. But above these we have the bat. Now bats are provided with wings of leather, which may be considered impervious to air. They are certainly large, but in many specimens—I regret that I am not naturalist enough to name them—they do not seem much out of proportion to the size and weight of a body constructed on animal, as opposed to bird, principles, and they do not move at a very great speed. A bat's power of flight depends then on the resistance offered by the wing to the air, and on the skill of the flyer, which I am inclined to think must be looked upon as an important factor. Any such action as that of the feathers in the wings—suggested by Mr. Bernays—is, I presume, out of the question.

It would not be difficult to construct wings on the same lines as those of a bat, and to supply power to actuate them at the necessary speed, but whether they would ascend or not is exceedingly questionable. But a point of view is apparently being overlooked, which, it seems to me, bears very forcibly on the subject. The flying creatures do not certainly devote all their power to rising vertically. A bird's flight as a rule is horizontal, or on a long incline up or down. Eliminating the effects of gravity, it attains its greatest speed horizontally; a perfectly vertical rise is only succeeded in with much toil, and a good deal of practice; to fly horizontally comes naturally—it is only necessary to watch a young bird to learn that. Birds rising from the ground make a light spring and then starting close to the horizontal, gradually rise in a curve to a desired height. In the case of many birds it may be noticed that they fly, so to speak, in waves, rising and falling. Are not then the following questions worth consideration:—Is not a bird's greatest power of flight in a horizontal line? If so, is it not possible that, as a rule, it rises by inclining its body and tail, so that the resistance of the air may force it to a higher level?—this is, of course, the action of the aëroplane. Would it not be well then to find out by what use of its wings a bird propels itself forward?

In conclusion, I would suggest to Mr. Bernays that he cover the wings of a strong pigeon with bags of gold-beater's skin. If its flight is seriously impaired there can be but little doubt that the feathers play an important part of the flight of a bird. The experiment will be more conclusive and less painful to the bird than the plucking which he suggests. BEN ZENE.

Ghent, June 27th.

BRAKE HORSE-POWER.

SIR,—I should have thought "C. E. B." would have been content with proving the wonderful fact that "the horse-power = $P \times \frac{\pi}{2} \times 60$," *i.e.*, equals a force × an acceleration × a constant —not to mention his confounding horse-power with foot-pounds per minute—without insisting upon having his mistakes pointed out. However, since he desires it, I will attempt to direct his attention to a few points on which he has gone astray.

In his letter dated June 1st, he correctly states that in the case of two weights P and W attached by a string, W resting on a horizontal board and P hanging over a pulley, the board must be moved with "an acceleration equal to that which W is receiving in an opposite direction from the action of P." He then states that "if the plank is moved with a uniform velocity, this velocity must be half the acceleration due to P," &c. This is obviously absurd, since a velocity can no more be equal to an acceleration than £1 to a wage of £1 per week, or a length of 3in. to a square of 3in. area. But, apart from that, it would be impossible to keep W at rest relative to the table by moving the board with a uniform velocity, except in the case where P = U W.

With regard to his proof published last week, the very fact of having to introduce elasticity ought to have deterred him from adopting a method in which the amount of work expended might be varied according to the modulus adopted. But the proof as it stands has several vital errors, such as the statement that the total work done per second equals kinetic energy of x before impact × number of impacts per second, which neglects altogether the energy that x possesses after impact due to its velocity $\sqrt{2gz}$.

He also arrives at the conclusion that when P rises to no appreciable height we still have work done, and such a marvellous kind of work too, viz., $\frac{Pv}{2}$, *i.e.*, a force × a velocity, and even this strange quantity may have any value we please, by changing that of v. It is very evident that if P does not rise, the number of impacts per second must be infinite, *i.e.*, equivalent to a constant pressure P − v W.

There are other errors which might be pointed out, but it would be of no advantage, since those already mentioned make the whole proof valueless. I consequently think that it would be wiser for us to retain the old and "utterly useless method" of calculating the brake horse-power, and whilst admiring the ingenuity displayed by "C. E. B." in attempting to prove an absurd statement true, I consider that he might with advantage pay a little more attention to the elementary but important subject of dimensions before again occupying your space. P. NICHOLLS.

Leeds, June 27th.

SIR,—Your correspondent "C. E. B." vainly endeavours by the display of much mathematics to establish a case. He has overlooked the trifling circumstance that the speed at which the brake wheel rim revolves is always a factor in the calculations. His reasoning and his experiments simply come to this, that a certain velocity of wheel rim is required to sustain the weight. But in practice the amount of friction is always so adjusted either by adding to the tail weight, or screwing up the tightening screws, that the weight will be supported and no more, being neither lifted nor supposed to fall. He has supposed conditions which never exist in practice.

But, on the other hand, it must be admitted, I think, that the now much used tail-rope brake gives very curious, and to me, inexplicable results at times. One such case occurred not long since in my own practice. We were running a small compound engine, the indicator diagrams were showing about 42-horse power, the brake about 28; the rope had been wetted, and the tail spring was pulling an average of 38 lb. I considered the result very unsatisfactory, but did not see how it was to be altered. However, I had the rope changed for a dry one. The tail spring then only pulled about 9 lb., and to my great surprise the speed remaining about the same, the indicated horse-power became 40, and the brake horse-power rose to 34. I am entirely at a loss to explain why. But I have repeatedly noticed that a light tail spring pull is always associated with a high efficiency.

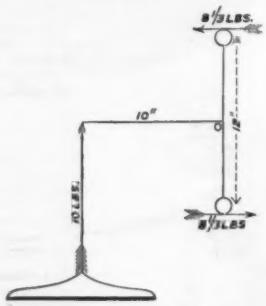
I shall be glad to know if any of your correspondents have had similar experiences. TESTER.

Westminster, June 27th.

A PROBLEM IN GYROSCOPES.

SIR,—"Twirler" is mistaken in supposing that I differ from Mr. Cox, by saying that it is the part of the disc to the right and left that keeps the gyroscope from falling. What I do say is, that the particles to the right and left have a primary effect, causing the apparatus to go round the support, and this same going round causes the top and bottom to have a secondary effect, tending to raise the whole disc up, and it is this secondary effect that is the direct cause of the top not falling, as I think "Twirler" will see, for he says in his last that he could understand my reasoning, if the disc did fall a little. Well, he can readily see that it does go round the support, though he may not see the reason why, and as exactly the same reasoning applies to the particles passing the top and bottom, being deflected by going round the support, as I applied in my last to the particles at the sides being deflected from their path by the action of gravity. "Twirler" will, at any rate, be able to see why the movement round the pedestal keeps the apparatus up. As to the disc anticipating the effect of falling, I do not say that. After being set spinning it does descend, but very gradually, almost imperceptibly. It falls just sufficiently to convert enough of its rotational energy into precessional movement, to overcome the friction of revolution.

And now as to how the weight is transferred to central support. Suppose the weight of the top to be 10 lb., all concentred in the rim of the disc, which we will suppose to be 12in. diameter and 10in. from the support. We then have a reaction upwards at the support of 10 lb. acting at a leverage of 10in., and causing a moment



of revolution about the centre of disc O—see Fig.—of 100 inch-pounds, which is counteracted by the top and bottom of the disc equally, that is 50 inch-pounds each, and, as the leverage at which these faces act is 6in., we readily obtain their amount, thus $\frac{50}{6} = 8\frac{1}{3}$ lb. acting at top, and the same at the bottom, as shown by the arrows. If the axis were 20in. instead of 10in., these forces of $8\frac{1}{3}$ lb. would need to be doubled to keep the axis horizontal, and the rate of precession would be doubled also to convert sufficient energy to overcome the effect of gravity. If the weight of disc were doubled it would have twice the energy, and the rate of precession would remain the same; but if a dead weight of 10 lb. were hung at the centre of gravity of the disc, the rate of precession would be doubled, as the energy of the system would remain unchanged, while gravity would act on twice the mass. If the rate of rotation were doubled, the energy would be quadrupled, and the rate of precession would drop to one-fourth.

In reply to Mr. Lawrence, I must confess that the calculation of the time of rotation for a given set of conditions is rather beyond me. My knowledge of the gyroscope has all been gained by experiments for the purpose of investigating the astronomical phenomenon known as the precession of the equinoxes. Mr. Lawrence's friend is quite right, if the velocity of rotation were infinite, the time occupied in one revolution round the pedestal would be infinite too.

The reason the precessional movement is faster as the speed of rotation falls off is this:—The disc then has less energy while its weight remains constant; it therefore needs to convert a larger proportion of its energy into rising effect to prevent falling. Of course to do this it has to fall a little faster too, but even then it comes down only slowly in a spherical spiral. If a simple gyroscope be made by fitting a heavy wheel on fine pivots in a light frame, and the wheel be spun and then suspended by a thread from the end of the frame with the axis horizontal, the precessional movement may be given by twisting the thread, and no energy being absorbed by friction, the disc will not fall. If the thread be twisted rather faster so as to accelerate the precessional movement, the axis will rise above the horizontal. It is very striking to see the top hanging by a thread with the axis pointing upwards at an angle of 45 deg., and the thread remaining vertical.

"Hub" is mistaken in supposing that it is not necessary for the disc to move round a central support. I am afraid he has been taking his science at a Japanese conjuring entertainment.

Whitehaven, June 27th. H. WAKE.

ENGLISH AND AMERICAN LOCOMOTIVES.

SIR,—I have read with much interest your recent articles on the subject of American and English locomotives. Your American contemporary's remarks, as quoted by you in your issue of May 27th, referring to the necessity for equal conditions of trial, if we would judge of the relative merits of the two types, are forcible, and to the point. In a recent number you illustrated a Baldwin design for a locomotive which was intended to compete under the above conditions with English engines on English lines. Unfortunately the scheme fell through. I write this letter to suggest that one or more English engines should be tested during the World's Fair on one of the leading roads from Chicago to New York. If Mr. Webb would send, say, the "Greater Britain," recently built by him, Mr. Worsdell the heavy compound that recently hauled 300 tons at eighty-six miles per hour on the level, and the Great Northern an 8ft. single, we should soon know beyond question the truth in the matter. Let the company competing send its own engineers and firemen. There are roads running to Chicago that can provide as smooth a track and as easy grades as any English locomotive could desire.

If they can surpass the American, English builders would find the competition a paying one; for the Yankee will always have the best, even should he have to send across the water to get it.

Astoria, Oregon, U.S.A., June 16th. J. B. WALKER.

SELF-BINDING REAPERS.

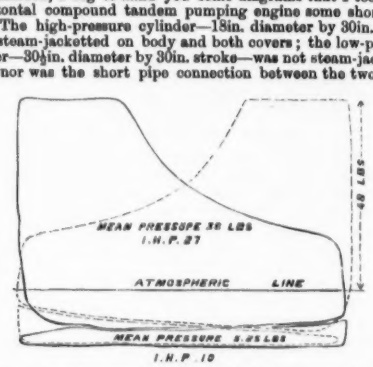
SIR,—I notice in Friday's ENGINEER a description of Bisset's—Blairgowrie—binder as shown at Warwick. As the writer of a letter to the ENGINEER last autumn* on the subject of doing away with canvas carriers, I could have wished for a more detailed description, as the improvement seems very much on the lines there advocated. The open back will be found, I think, almost a necessity this year, at all events in this district, as from the long continued wet weather we shall probably have a rank twisted crop to deal with.

June 27th. AGRICOLA.

* THE ENGINEER, October 20th, 1891, p. 275.

THE INFLUENCE OF STEAM JACKETS.

SIR,—Referring to your leader of 10th inst., and Mr. Donkin's letter thereon, I beg to hand you some diagrams that I took from a horizontal compound tandem pumping engine some short time ago. The high-pressure cylinder—18in. diameter by 30in. stroke—was steam-jacketted on body and both covers; the low-pressure cylinder—30½in. diameter by 30in. stroke—was not steam-jacketted at all, nor was the short pipe connection between the two. The



Boiler pressure, 58 lb.; revolutions, 18; high-pressure cylinder, 18in.; low-pressure cylinder, 30½in.; stroke, 30in.; scale, 20 lb. per inch.

latter was covered with non-conducting material. You will notice there is a tremendous drop in pressure after the steam leaves the high-pressure cylinder. Does this not go to prove that the low-pressure cylinder is the one that needs the jacket?

June 21st. NORTH ENGLAND.

FAST TRAINS IN GERMANY.

SIR,—The running of 98¾ miles in 113·72 minutes, as given on page 551 of THE ENGINEER of June 24th, may be compared with the running of the Glasgow day express on the Midland Railway, from Leicester to St. Pancras, 96½ miles. This train is timed to leave Leicester at 5·25, and without any intermediate stop, arrive at 7.20 = 115 minutes. But it is generally a few minutes late in starting, and yet arrives in time when not less than 105 minutes are available. The train has a heavy Pullman car and six other coaches. The road has worse gradients than the German line.

Leeds, June 25th. M. R.

GAS ENGINES AT THE WARWICK SHOW.

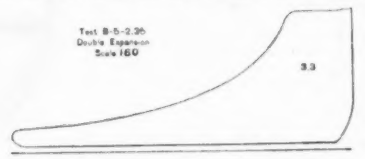
SIR,—We shall be obliged if you will allow us to say, with reference to our "easy" starter described by you on page 542 of THE ENGINEER, that the arrangement is fully covered by letters patent. Perhaps it is permissible to add that our larger engines are also fitted with a very simple "self" starter.

The Trent Gas Engine Company, Nottingham, June 25th. RICHARD SIMON, Managing Director.

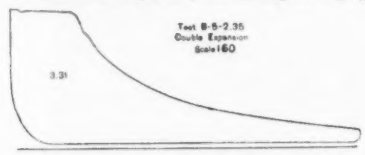
TWO-CYLINDER VERSUS MULTI-CYLINDER ENGINES.

By SAMUEL M. GREEN, Holyoke, Mass., AND GEORGE I. ROCKWOOD, Worcester, Mass.*

IN a recent issue of a technical journal,† the theory was advanced by Mr. Rockwood that more than two cylinders in a compound "multi-cylinder" engine were unnecessary to secure the highest theoretical economy in the use of steam. This proposition was severely criticised and declared to be inconsistent

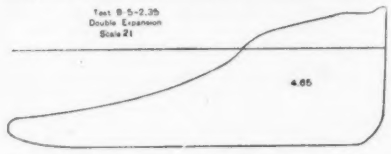


with the modern philosophy of the steam engine. It may, therefore, be interesting to the members of the society to give their attention to an account of a series of tests of a triple-expansion engine, so constructed as to permit "cutting out of the circuit" the intermediate cylinder, and running the high-pressure

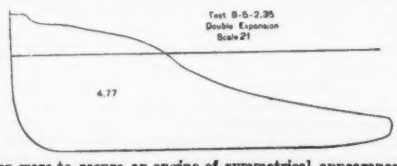


and low-pressure cylinders as a two-cylinder compound, using the same conditions of initial steam pressure and load.

Engine.—The engine is a triple-expansion condensing engine, designed by George I. Rockwood for the Merrick Thread Company, Holyoke, Mass., and built by the Wheelock Engine Com-



pany, Worcester, Mass. The high-pressure and intermediate cylinders are tandem on one frame, the low-pressure cylinder occupying the right-hand position to an observer standing at the cylinder and looking toward the shaft. The relative proportions of the cylinders are somewhat novel. As the objects of the

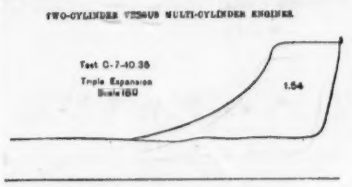


designer were to secure an engine of symmetrical appearance, of uniform turning moment at each crank, and of highest attainable steam efficiency, and also to make it possible to run the low-pressure side with high-pressure steam, in case of accident to the high-pressure side, the tandem cylinders were made of shorter stroke than that of the low-pressure cylinder The high-pressure cylinder was put next to the frame. The exhaust steam from the

* Presented at the San Francisco meeting, May, 1892, of the American Society of Mechanical Engineers, and forming part of vol. xiii. of the Transactions.

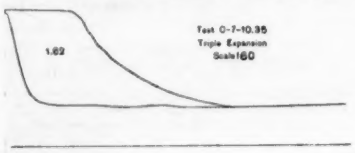
† *Railroad and Engineering Journal*, December, 1891.

high-pressure cylinder passes directly into a receiver of the tubular re-heater variety, and thence directly into the intermediate cylinder. Another similar receiver lies between the intermediate and low-pressure cylinders. These two receivers are so connected that the exhaust from the high-pressure cylinder may pass through both into the low-pressure cylinder without going through the intermediate cylinder, the steam and exhaust pipes of which are provided with valves. The first and second cylinders are jacketted on heads and barrels; the heads only of the low-pressure cylinder are jacketted, and all receiver and cylinder jackets contain steam at full boiler pressure. The cylinder jackets consist of cored



spaces. The jacket-drips all collect into one pipe 1¼in. in diameter, which discharges into a reservoir, whence it is returned through a steam loop to the boiler, and in no instance are the jackets connected with the cylinder steam chests.

The valve gear of the high-pressure cylinder is of a new type, designed to operate gridiron valves under heavy pressures. The valve gears of the intermediate and low-pressure cylinders are, in all respects, such as have been used heretofore on engines built by the Wheelock Engine Company. The governor operates only upon the cut-off mechanism of the high-pressure cylinder, the releasing gears of the other two cylinders having independent hand adjustments. In case of accident to the high-pressure side



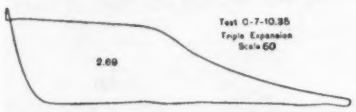
of the engine, however, means are provided for connecting the governor with the cut-off mechanism on the low-pressure cylinder.

The engine is located at some distance from the boiler—a Manning upright of 175 rated horse-power—the supply pipe being 325ft. in length. A separator, placed about 10ft. from the engine, collects the entrained and condensed water, which is also returned through a steam loop to the boiler. The condenser is of the jet type, supplied from the canal with injection water, which is removed by a direct-connected air pump.

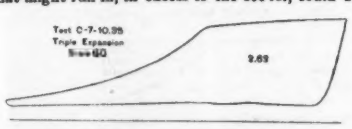
Dimensions of Engine.

	H.P.	I.	L.P.
Diameter of cylinder	12in.	16in.	24½in.
,, ,, piston-rod	2in. and 2¾in.	2in.	3½in.
Stroke of piston	36in.	36in.	48in.
Clearance in percentage of piston displacement	2 per cent.	4 per cent.	3 per cent.
Inside diameter steam pipe	5in.	6in.	9in.
,, ,, exhaust pipe	6in.	7in.	10in.
Area of steam port	13in.	21in.	38in.
,, exhaust port	16·5in.	25in.	60in.

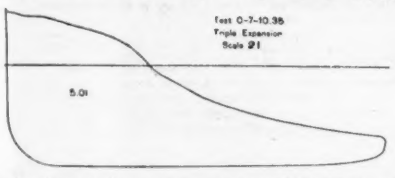
Method of testing.—It was considered unnecessary to make coal measurements, as they have no bearing on the results. The feed-water was measured in the following manner:—One large tank was employed as a reservoir, from which the feed-pump drew its supply. Above this tank, on a platform, were placed a pair of



scales and a small tank which held about 400 lb. of water. Just before the trials the scales were sealed by the Sealer of Weights and Measures. To the beam of these scales was attached a long pointer. They were accurately balanced with the tank empty, and the position of the pointer was noted and marked. A scale weight of 400 lb. capacity was then placed on the beam, and water was run into the tank until the pointer resumed its balanced position, thus giving just 400 lb. of water in the tank. A small valve was provided in the side of the weighing tank, so that any water that might run in, in excess of the 400 lb., could be readily



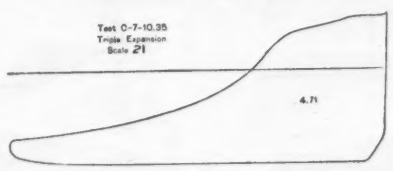
withdrawn. A counter was also attached to the tank, so that every filling would be automatically registered independently of the attendant's registration. In this way an accurate count was kept of all the water pumped into the boilers. The boiler feed-pump was connected only with the reservoir and feed-pipe to the boiler used during the tests. Steam for this pump was taken from other boilers. During the period of testing, the water of condensation from the jackets, was not allowed to return to the boilers, but was drained through pipes connected with the lowest points in each of the jackets, each pipe leading down to a separate reservoir provided with a gauge glass. The discharge pipe, ½in.



in diameter, from each reservoir, was connected with a surface condenser and discharged into a weighing tank. An accurate record was kept of all water drawn from each jacket during each test. A revolution counter indicated accurately the number of revolutions of the engine. Six Tabor indicators were kindly loaned for these tests by the Ashcroft Manufacturing Company, of New York. The instruments were all in the best condition and were sent directly from the factory.

The following descriptions of the tests will illustrate the manner in which each trial was conducted:—At one o'clock p.m., the engine having been running for fifteen minutes, electric bells were sounded in the engine and boiler rooms, the heights of the water in the boiler and in the lower tank were measured, the reading of the scale counter was noted, the heights of the water in the various jacket reservoirs were taken, and the test began.

During the trials, simultaneous indicator diagrams lasting half a minute were taken every half-hour, which was considered often enough in view of the exceedingly steady load on the engine; and pressures and temperatures were carefully noted each time. Every hour the water in the boiler and tank was brought to the heights observed at the time of starting the test, and observations were made for a check on the final result. Just before the time of closing, the boiler pump was stopped, the water in the boiler was allowed to fall below the point of starting, and at precisely



six o'clock the bells were sounded, the engine shut down, and steam was shut off from the jackets. The heights of the water in boiler and tank were brought to the same level as at starting. Three preliminary tests of the engine were thus run, in order to accustom the attendants to their duties. In all the tests made, the reading of the thermometer in the calorimeter was practically constant, showing a uniform degree of moisture in the steam amounting to 2·64 per cent.

On Wednesday, April 6th, two five-hour formal trials of the engine, run as a two-cylinder compound, were held. During Thursday, a holiday, the change was made to a triple-compound, and on Friday two five-hour trials were again made. The sample diagrams appended show the valve setting and degree of expansion. The results are seen in Table No. II. They are practically identical, and would seem to support Mr. Rockwood's theory that the receiver may be so constructed as to take the place of the intermediate cylinder or cylinders of the multi-cylinder engine. As these tests were held so shortly before the spring meeting of the society, the time allowed in which to prepare this paper was much too limited to admit of the exhaustive treatment which the importance of the subject demands. It is hoped that at the next meeting the results of further trials, together with their proper analyses, may be presented for further consideration. But the results of these tests, it is believed, show an economical performance surpassing the best records hitherto published in this country, and clearly indicate that more than two cylinders are unnecessary to secure the highest attainable economy in the use of steam.

TABLE II.—*General Results of Four Tests of a Triple Compound Engine, run both as a Triple and as a Double Compound.*

Test.	Engine.	Duration. Hours.	R.P.M.	Average steam pipe pressure.	Average indicated horse-power.	Water per I.H.P. per hour.	Dry steam per I.H.P. per hour.	Weight of water used in jackets per hour.
						lbs.	lbs.	lbs.
A	12 × 36 / 24½ × 48	5 (7—12)	79·2	142·	187·11	13·41	13·06	330·3
B	12 × 36 / 24½ × 48	5 (1—6)	79·3	142·	180·71	13·11	12·76	330·3
C	17/8 × 36 / 24½ × 48	5 (7—12)	79·0	142·	199·08	13·01	12·67	416·0
D	17/8 × 36 / 24½ × 48	5 (1—6)	79·0	143·	178·16	13·25	12·90	388·8

THE TRAMWAYS INSTITUTE.

UNDER the presidency of Mr. W. Carruthers-Wain, a special meeting of the Tramways Institute of Great Britain and Ireland was held at the Guildhall Tavern, London, E.C., on Tuesday. The following are abstracts of some of the papers read.

Mr. T. Arnull, assistant surveyor of Birmingham, read the first paper on "Permanent Way Construction, especially as regards Wear and Tear and Depreciation." The author pointed out that when the tramways were first laid in Birmingham, it was decided that they should be put down by the Corporation and maintained by the latter on terms to be agreed upon with the several companies concerned. The first lines were laid in that town in 1872, the Larsen system being adopted; but that method was now a thing of the past. Steam traction was introduced in 1882, and it had since received a very extensive development. The traffic on some of the steam routes in Birmingham had already produced some results which might serve as data to assist in determining what that depreciation fund should be in similar or even in dissimilar circumstances. The first line laid for steam in Birmingham was the Birmingham and Aston route in 1882. It comprised four miles of double line of 3ft. 6in. gauge, the rail used being known as Barker's—a steel rail, 42 lb. per yard—keyed to a cast iron sleeper. The sleepers, which were cast in lengths of 2ft. 11in., were laid with a gap of 1in. between them, so that they were practically continuous. Shortly after the line was opened the rails began to work loose at the joints, which were always in the centre of sleepers. Nothwithstanding all tightening up and replacement of keys, this defect gradually spread until the rail was loose from one end to the other, and the next result was the loosening and sinking of the paving stones alongside. It was found that the steam traffic was subjecting the rail to a process of "cold rolling," which lengthened the upper surface, whilst the lower parts of the rail remained unaltered. The rail tended to assume an arch or bow form, and it was no longer straight on plan, but curved. The effect was that when keyed down the rail was always in a state of strain, and the top of the sleeper wore away as fast as the top of the rail. This process went on until the flange of the wheel reached and ran on the bottom of the groove, and then destruction proceeded more rapidly, until towards the end of 1886 some of the rails began to split and had to be taken out. Four years seemed a short life for a tram rail, which in this case was in a macadam road, but the traffic was very heavy. Before the end of 1889 all the rails had to be replaced, after the passage over them of 400,000 steam cars in seven and a-half years. That was the result of their experience in Birmingham. If renewed in the night time the cost of a single line would be about £2000 a mile with girder rails, or 1½d. per car mile as a sinking fund.

The conclusion had been arrived at from their own practice and investigations elsewhere, that that system with Barker rails was not suitable for steam traction. Hence when the Corporation was called upon in 1883 to construct what is now termed the Birmingham Central Tramways Company, it was decided to adopt the Gowan or girder rail, 7in. deep to suit 6in. paving, 7in. wide on bottom and weighing 98 lb. per yard. The joints were made of two 16in. fish-plates with four bolts. They stood well for the first two or three years; after this they began to work loose, and the ordinary remedial methods—tightening up the bolts and often replacing them, repacking the rail, &c.—only proved a temporary cure. The chief reason, Mr. Arnull believed, was that on a steam route the rail generally was not continuously and equally supported, and that it never could be for long together. Many attempts had been made to deal with the weakness at the joints, but with imperfect success. In the last route constructed by the Corporation, the length of the fish-plates had been increased from 16in. to 24in., and the number of bolts from four to six. A number of Marshall's sole-plates were used. The long plates were practically no better than the short ones, and it was found that the defect was rather with the clips. The author therefore suggested that the two centre clips should be brought together and coalesced into one, the two bolts being retained. This form of clip proved a great improvement upon the old one, and he believed was now as good as a sole-plate could be. With a view to find what the effect of increasing the bearing area at top and bottom of the fish-plates would be, a number of cast iron plates 16in. long were used. When these were used combined with a sole-plate, the joint was better than any tried in Birmingham. After referring again to the cold rolling process, which he considered as one reason why there was so much trouble with the joints, Mr. Arnull concluded by stating that the figures of rail sections exhibited showed that on a straight road a girder rail would be worn out and require replacing after the passage over it of less than three-quarters of a million of steam cars.

Mr. L. Epstein, in his paper on "Accumulator Traction," pointed out that the Epstein accumulator, unlike other cells, contained only three electrodes, and that the active parts were produced out of the original substance of the lead itself. One cell weighed 45 lb., and the weight of the 96 cells, as used generally on a car, would be slightly under two tons, or about one-fifth of the total weight of the car, which with its full load of passengers, was a little over 10 tons. This battery would allow the car to run at an average speed of 7½ miles for about four hours, on the assumption that the average expenditure of the battery was about 6-horse power, certainly not an excessive estimate of the power required. He gave some tables to represent the estimated relative costs of working per car mile with accumulators and with horses.

It was found only necessary to charge the battery with a current which exceeded the previous discharge by 5 per cent., and the efficiency—that is, the total energy given out as compared with the total energy put into the cells—was as high as 78 per cent. Allowing for loss in the dynamos, gearing, and motors, continued Mr. Epstein, they arrived at the efficiency of 63 per cent. between the horse-power generated by the engines and the brake horse-power on the car motors; and allowing for 25 per cent. for the increased weight of the accumulator car, a total efficiency of 47 per cent. was reached, as against an average of 32 per cent. of the trolley system in the United States. Mr. A. J. Jarman read a paper on "Accumulator Traction," which added a little information to that which we have already published concerning the Jarman system.

A paper on the Connelly motor, by Mr. Sharpe and J. E. Weyman, was read and attracted much attention. On Wednesday afternoon the Connelly motor was shown at work on the tramway near South Bermondsey Station, and was then officially inspected by Major-General Hutchinson for the Board of Trade. We shall refer to this in another impression.

GREAT WESTERN RAILWAY WORK, SOUTH DEVON.

THE view of the Ivybridge Viaduct, showing the old work and the new work in progress, completes our illustrations of the important widening operations being carried out in South Devon by Messrs. Pearson and Sons, as contractors, Mr. Trench being the engineer. On page 548 will be found complete particulars of the operations carried on, to which our readers can refer. The extension of timber made by Brunel is an excellent comment on the position of the iron manufacture in his day.

TENDERS.

PWLLHELI SEWERAGE WORKS.

THE following is a list of tenders for the construction of an outfall sewer for the Pwllheli sewerage works—Engineers: Messrs. Thomas Roberts and Son, Portmadoc:—

	£	s.	d.
Griffith Griffith, Emw, Criccieth	4977	0	0
David Williams, Carnarvon	3989	0	0
Evan M. Jones, Marine-terrace, Barmouth	3397	0	0
John Hunter, Park-street, Croydon (accepted)	3347	0	0

THE BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—The annual pic-nic of the above Association was held on Saturday last, June 18th, by a visit to Kenilworth.

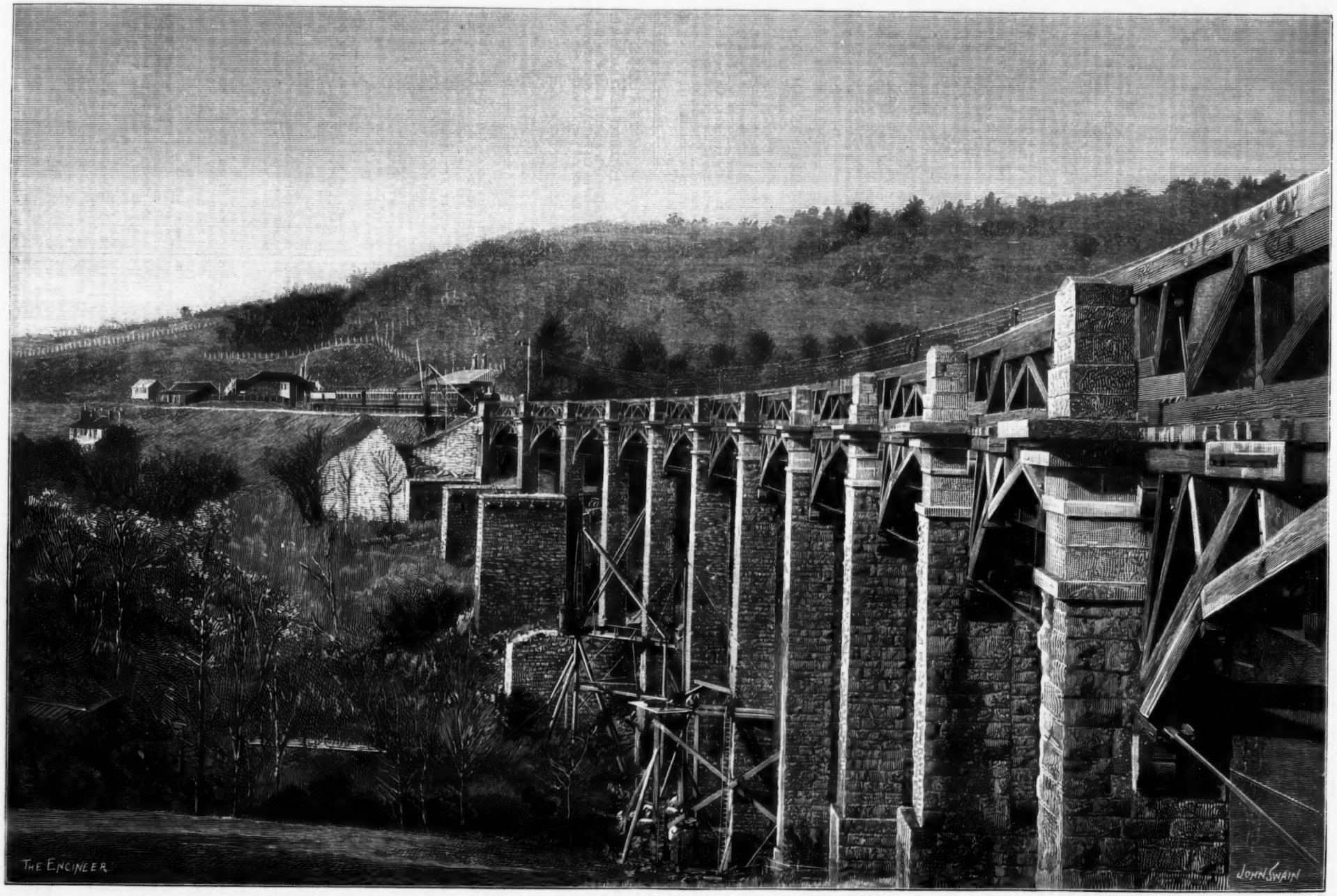
LAUNDRY APPLIANCES EXHIBITION.—Arrangements are being made for holding a Laundry and Domestic Appliances Exhibition at the Central Hall, Holborn, London, in August. It is intended that the exhibition shall, as far as possible, represent all kinds of modern domestic and public laundry machinery and appliances, and afford actual test of the various machinery. The "Pompadour" ladies' band will play every afternoon and evening. The offices are at 43, New Oxford-street, London, W.C.

THE JUNIOR ENGINEERING SOCIETY.—On the afternoon of Saturday, 11th ult., by invitation of the Patent Victoria Stone Company, a visit was paid to their works at Stratford, the party being under the guidance of Mr. Harry Rogers, who fully explained the processes in connection with the manufacture. The stone is composed of machine-washed granite siftings, bound together by Portland cement, and cast into slabs 2in. thick, their specific gravity being 2·7. After setting they are steeped for ten days in a solution of silicate of soda, by which process they are hardened. This indurating solution is obtained by boiling Farnham stone with caustic soda, previously made into a solution with water; the silica of the stone dissolves, and the solution is diluted for use. The slabs are taken out and scoured with clean water, after which they are stacked for ageing a period of at least three months before being sent away. The results of the use of this particular kind of stone have in every instance been of a most satisfactory character. Messrs. Bullivant and Company's steel wire, netting, hawsers, and ropes manufactory, Millwall, was visited on Friday evening, 17th June, Mr. Pulham Bullivant assisting in showing the members round. The works occupy an area of more than three acres, which is entirely covered by the shops in which the construction of wire rope, and the weaving of wire netting is carried on. An engineering plant is attached for constructing new machinery, and for making such goods as are required in connection with the business. There are stranding machines of six, twelve, eighteen, and twenty-four bobbins, and closing machines for making rope up to 21in. circumference, and in pieces of thirty tons weight. For purposes of testing, a horizontal hydraulic testing machine is employed capable of working to a strain of 100 tons. The wire netting machines produce nettings with mesh varying from ¼in. to 4in. A large quantity of the wire netting made is exported to Australia for use there in connection with the destruction of rabbits. One of the upper shops is devoted to the winding of springs and bobbins for the netting machines, in the lower part being situated a pair of 25 indicated horse-power steam engines for driving them. In the galvanising shop there are three baths for the treatment of netting, and two for wire rope. The factory is capable of turning out weekly about 170 tons of wire rope, and 200 miles of netting. At the conclusion of each visit the thanks of the party were expressed by Mr. P. J. Waldram, and acknowledged respectively by Mr. Rogers and Mr. Bullivant.

GREAT WESTERN RAILWAY WORKS, SOUTH DEVON.—IVYBRIDGE VIADUCT

MESSRS. PEARSON AND SONS LONDON, CONTRACTORS

(*For description see page* 11)



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CONTENTS.

THE ENGINEER, July 1st, 1892.

	PAGE
EXPLOSIVES IN 1891	1
THE BRITISH NAVY UNDER THE PRESENT ADMINISTRATION	2
MINES, MINING, AND METALLURGY AT THE CHICAGO EXHIBITION (Illus.)	3
THE INSTITUTE OF NORTH-EAST COAST SHIPBUILDERS AND ENGINEERS	5
HARBOURS AND WATERWAYS	6
OPENING OF PRESTON DOCKS	6
RAILWAY MATTERS	7
NOTES AND MEMORANDA	7
MISCELLANEA	7
THE ROYAL AGRICULTURAL SOCIETY'S SHOW. (Illustrated)	8
COMPOUND ROAD LOCOMOTIVE	9
LETTERS TO THE EDITOR—Aërial Navigation—Brake Horse power—A Problem in Gyroscopes—English and American Locomotives—Self-binding Reapers—The Influence of Steam Jackets—Fast Trains in Germany—Gas Engines at the Warwick Show	10
TWO-CYLINDER *versus* MULTI-CYLINDER ENGINES. (Illustrated.)	10
THE TRAMWAYS INSTITUTE	11
GREAT WESTERN RAILWAY WORKS IN SOUTH DEVON. (Illustrated.)	11
TENDERS	11
GREAT WESTERN RAILWAY WORKS, SOUTH DEVON—IVYBRIDGE VIADUCT	12
LEADING ARTICLES—The Gas Supply—Brake Horse-power—The Central London (Electric) Railway Bill—Boring for Water—Milling and Baking Exhibition	13
LITERATURE	14
BOOKS RECEIVED	15
ON THE PROBLEMS OF STEAMSHIP PROPULSION	15
ELECTRIC LIGHTING IN OXFORD. (Illustrated)	15
AMERICAN ENGINEERING NEWS	16
LAUNCHES AND TRIAL TRIPS	18
LOCOMOTIVE ENGINES IN NEW SOUTH WALES	18
LETTERS FROM THE PROVINCES, &c.—The Iron, Coal, and General Trades of Birmingham, Wolverhampton, and other Districts—Notes from Lancashire—Notes from Sheffield—Notes from the North of England	19
Notes from Scotland—Notes from Wales and Adjoining Counties—Notes from Germany	21
AMERICAN NOTES	22
NEW COMPANIES	23
THE PATENT JOURNAL	23
SELECTED AMERICAN PATENTS	23
PARAGRAPHS—Mudd's Patent Expansion Cylinder for Tank Steamers and Storage Tanks, 2—The Birmingham Association of Mechanical Engineers, 11—Laundry Appliances Exhibition, 11—H.M.S. St. George, 18—Promotion in the Dockyards, 23.	24

TO CORRESPONDENTS.

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S. H.—*Box on "Heat." London: E and F. N. Spon. "Practical Ventilation and Warming," by Joseph Constantine. London: J. and A. Churchill.*

AN AMATEUR.—*You may use the valves upside down if you like, provided they are fastened down in the middle, and without this precaution at the angle shown in your sketch. We have repeatedly used them on vertical condenser walls.*

E. L. (Central Railway, Queensland).—*Scores of patents have been taken out for establishing electrical communication in trains. The system is in daily use on several railways. On the London, Brighton, and South Coast, for example, it has been employed for many years. There is nothing left to patent save details.*

OILING THE WAVES.

(To the Editor of the Engineer.)

SIR,—Will some reader kindly give me the name of a maker of automatic apparatus for throwing oil on the sea when in a state of commotion, in order to break the force of the waves? There is an appliance pear-shaped, and I should like to know the maker of this.

J. G. N.

Liverpool, June 28th.

FOREIGN SEWAGE PRECIPITATION WORKS.

(To the Editor of The Engineer.)

SIR,—Referring to the report contained in your issue of the 17th inst. of my paper on "Foreign Sewage Precipitation Works," read by me before the Society of Engineers on the 13th inst., the following is from a letter just received by me from Mr. Lindley, of Frankfort:—"There is a slight mistake which I should be glad if you would have corrected at once, as I should be sorry if it got copied into other papers. The sentence should run thus: 'The system of water-closets, drains, and sewers was commenced twenty-five years ago, under the direction and according to the plans of Mr. W. Lindley—not "W. H.," and not "the late," as I am thankful to say my father is living, hale and well, at Blackheath—and completed by his son, Mr. W. H. Lindley, the present engineer-in-chief of the city.'"

You would greatly oblige, Sir, by inserting the above correction in your next issue if possible.

ALBERT WOLLHEIM, C.E.

Leadenhall House, E.C., June 28th.

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THE ENGINEER.

JULY 1, 1892.

THE GAS SUPPLY.

A NEW feature in the manufacture of gas is now becoming prominent, and enters into the calculations presented by Mr. J. W. Field in his "Analysis" of the accounts of the principal gas undertakings of the United Kingdom for the past year. What is termed the "enrichment" of gas is being carried out to an extent which affects the reckoning as to the quantity of coal carbonised by certain of the companies. Mr. Field states that in dealing with enriching materials other than cannel, he has reduced them to their equivalents in tons of Lesmahagow, and has adopted, on this occasion, for petroleum oil the basis of 75 gallons per ton, and for petroleum spirit 50 gallons, these being—as he explains—the figures most generally accepted at this experimental stage in the process. Mr. Field acknowledges that the plan of increasing the tonnage of coal by these equivalents is not wholly free from objection, but he has been induced to adopt it for the present issue of his work, by the advantages which it offers in comparing the principal items in the production of gas. In their statement of accounts for the half year ending with December last, the directors of the Gas Light and Coke Company specify that the quantity of cannel coal carbonised during that period was supplemented by the equivalent of 14,631 tons of cannel in the form of oil. As the cannel itself was not much more than 23,000 tons, it will be seen that the oil was an appreciable agent in heightening the lighting power of the gas. The South Metropolitan Company is adopting the same method. But we do not find that any of the suburban or provincial companies included in Mr. Field's statistics have entered upon the use of oil in this way. They are doubtless waiting to see how far the plan succeeds in other hands. If the experiment answers in the case of the leviathan companies, we may expect the lesser to take advantage of the experience thus gained. Stimulated by the progress of the electric light, the gas companies may adopt yet other improvements in their manufacture, to their own profit and the benefit of the public. The resources of science in relation to this industry are not exhausted, even after a century of gas-making.

At the close of last year the three London gas companies had raised £15,736,000 of capital, and had power to raise a further sum of £2,172,000. The coal carbonised during the year exceeded 3,000,000 tons, more than two-thirds of this enormous quantity being consumed by the Gas Light and Coke Company. The quantity of gas sold was not far short of 28,000 millions of cubic feet The figures are almost unmanageable, and Mr. Field simplifies them by making a thousand cubic feet represent a unit. We are rather struck by the fact that whereas in 1890 a ton of coal produced 9435 cubic feet of gas "sold," last year the proportion fell to 9243ft. This, however, meets with a probable explanation when we perceive that the cannel coal carbonised last year was only 2·75 per cent. of the total, even including the estimated equivalent in cannel of the oil and spirit used in the December half-year, whereas in 1890 the percentage was 3·58. But it is rather perplexing to find that whereas one of the companies—the Commercial—increased its proportion of cannel, the gas sold per ton of coal in that instance showed a decline. Another puzzle consists in the fact that the South Metropolitan Company reduced its proportion of cannel, and yet increased the sale of gas per ton of coal. In the case of the Gas Light and Coke Company, the reduction in the proportion of cannel coal is marked, and is followed by a corresponding reduction in the yield of gas per ton. The gas unaccounted for shows on the whole a slightly decreased percentage, due to an improvement on the part of the largest undertaking; but in the case of the Commercial Company there is rather a decided increase in the waste. A very encouraging result for the three London Companies consists in an increased sale of gas to the extent of nearly 5 per cent. compared with the previous year; whereas 1890 showed an advance of little more than 3 per cent. compared with 1889. The net gas rental exceeded £3,600,000, an advance of more than £300,000 on the year preceding. Residual products brought in £1,322,000, and the total income rose to above £5,000,000, being an increase for the year of £326,000. The growth in the receipts from residuals was not much, being under £16,000. Meter and stove rental rose by £8000, the total for these items exceeding £99,000. For meter rents we have no great love, but the hire of stoves is a beneficent business, which if diligently promoted by the companies, cannot fail to be increasingly profitable. In the latter half of last year, the Gas Light and Coke Company received above £7800 from this source, being £1600 more than in the corresponding half of the previous year.

Those who think it desirable that gasworks should be municipal property may ponder the fact that the rates and taxes paid by the London gas companies last year amounted to more than £200,000. In some shape or way this burden must fall on the ratepayers should ever the gas undertakings be bought up by the local authority. This sum is equal to 1·77d. per 1000ft. of gas, whereas directors and auditors cost less than a tenth of a penny. After all charges are paid, including interest on loan capital, there remains to the London companies a net profit of nearly £877,000, equal to 7·36 per cent. on the stock and share capital. It seems a little strange that the dividend paid on this capital should average 10·73 per cent. But £402,000 was paid on account of dividends in excess of the actual profit, the reserve funds being drawn upon to make good the deficiency. In the case of the Gas Light and Coke Company this deficiency was no less than £281,000. Among the twelve suburban companies there occurs a deficit of £34,000 on the dividend paid, only three of their number showing a surplus. In other words, the net profit was £173,000, while the sum paid in dividends was £207,000. In the case of the ten provincial companies included in the statistics the dividends paid exceeded the profits by more than £52,000, only two showing a surplus. The eight corporations of which an account is given employ more than £8,000,000 of capital in their gas undertakings, while the ten companies use considerably less than £6,000,000. But the profit made by the companies was £339,000, while that made by the corporations was £205,000. Of this latter amount nearly £123,000 went in aid of rates, while £46,000 was taken by the sinking fund, leaving £36,000 as a surplus. It is evident that the sum which goes in aid of rates is, in the first instance, a tax upon gas. Under a municipal body this money is really due to the gas consumers in the shape of a rebate. But the happy delusion is cherished that the ratepayer is benefited because the rates are reduced by the profits on the gas, whereas the money that goes into one pocket has previously been taken out of the other. As we have shown on a previous occasion, the only parties benefited are those who pay rates but burn no gas. The rates are lessened, but the amount by which they are reduced has first of all been extracted from the gas consumers, by a charge over and above the cost of the article supplied. The most straightforward course would be to supply gas without making a profit. Where there are no dividends to pay, the public ought to be the better for it; but by the present jugglery extravagance in the expenditure out of rates is encouraged by the facility with which the rates can be kept down by drawing on the profits from the gas. Our contention is, that the gas account should stand by itself, and should be kept perfectly clear from the question of rates. But local authorities are always anxious to get something in aid of rates. This is not to be marvelled at, only the process should be understood by the parties who have to pay.

The Corporations of Birmingham, Manchester, and Leeds are among the eight dealt with in the "Analysis." The entire eight of these municipal authorities carbonise little more than half the quantity of coal consumed by the three London companies, but the proportion of cannel has a much higher average, and the lighting power of the gas is superior. The quantity sold per ton of coal is less than in London, though the average is precisely the same as that of the Commercial Company, or a little over 9000ft. The price ranges from 2s. 1d. per 1000ft. at Leeds, to 2s. 4d. at Birmingham, 2s. 6d. at Manchester, and 2s. 8d. at Bolton. The gas, as supplied, is said to have a lighting power of 17·25-candles at Birmingham, 18·04 at Bolton, 19·26 at Manchester, and 19·40 at Leeds. At Nottingham the prescribed lighting power is 12-candles, whereas that supplied is said to be 18·50. Oldham has 20-candle gas in place of 14-candle. In London the prescribed lighting power of common gas is 16-candles, and this is exceeded by less than half a candle in the supply. The ten provincial companies dealt with carbonise in the aggregate less coal than the eight corporations, but the gas sold per ton is higher and exceeds the London proportion. There is great diversity in the lighting power supplied, and it seems odd that it should be so. There ought to be some rule in regard to this matter, or else some explanation why Brighton should have 14·54-candle gas while Preston has 18·50 and Liverpool 21·60. A special cannel supply exists in London, furnished by the Gas Light and Coke Company, but forms less than 3 per cent. of its total supply. Looking back in the order of time, it is interesting to observe the enormous growth in the gas industry of the metropolis, a growth which happily bears the mark of economy in its result. In 1869, the coals carbonised in the London gas factories were less than 1,200,000 tons. The present consumption multiplies this by two and a-half. At the former date the capital employed was at the rate of £6 13s. 8d. per ton of coal, and 15s. 10d. per 1000ft. of gas sold. The capital now employed is £5 14s. 4d. per ton of coal, and 12s. 3d. per 1000ft. of gas. Directors and auditors cost nearly £23,000 in 1869, as against little more than £12,000 last year. The common gas at the earlier date was partly 14-candles in lighting power, but chiefly 12, and the price ranged from 3s. 2d. to 4s. 6d. per 1000ft., the price throughout the City, or very nearly so, being 4s. Last year the charge for common gas ranged from 2s. 3d. to 2s. 9d. per 1000ft., the gas being also raised in lighting power from what it was in 1869. It cannot be said that the amalgamation which reduced thirteen companies to three has been without some advantage to the gas consumers of the metropolis.

BRAKE HORSE-POWER.

WE have published two letters, the author of which assails the commonly-received views concerning the story which a friction brake tells. It is not necessary that we should express any opinion concerning the soundness or unsoundness of our correspondent's reasoning. It suffices to say that he is an engineer, and by no means deficient in mathematical knowledge. His letters are interesting, because they are the outspoken expression of an uncertainty which lurks in the minds of many men concerning the truthfulness of brakes. History repeats itself. Nearly thirty years ago, Mr. Porter, who introduced the Allen engine into this country, carried out a series of experiments with leather belts and cast iron pulleys, which were in many respects identical with those mentioned by our correspondent "C. E. B.," and arrived at the conclusion that there was an unconsidered element in the action of brakes, the neglect of which might vitiate conclusions drawn in the usual way. We may recall to the memory of our readers the memorable discussion which took place in our columns after the Newcastle Show. For very many years the Appold brake had been accepted as trustworthy. It is now known that its use involved the possible occurrence of gross errors. Its place has been taken by the tail rope brake. It remains to be seen whether that is really in all cases more satisfactory. We do not say that it is

impossible, or even difficult, to use it so that error will be nearly or quite eliminated. Indeed, as much as this may be said of the discarded Appold brake; but we believe that the tail rope brake *can* be employed in such a way that it gives erroneous results, and before we have done we shall call attention to what appears to us to be a glaring and remarkable example of this. But it is advisable in the first instance to consider for a moment what the theory of the friction brake is.

It is assumed that when a revolving wheel supports a weight which would otherwise fall, the amount of power expended is precisely the same as if the wheel actually raised that weight each revolution through a height equal to the circumference of a circle with a radius equal in length to the distance between the centre of suspension of the weight and the centre of the revolving wheel. A moment's consideration will, however, suffice to show that the actual natural processes involved are not nearly so simple as this theory postulates. The revolving wheel supports the weight solely by the friction which is exerted between the brake blocks or rope and the wheel run. But energy cannot be dissipated in this way, and so we find that the energy imparted by the engine is converted into heat. The brake wheel would become very hot if means were not taken to keep it cool. The approved method consists in maintaining a thin film of water inside the rim of the brake wheel, which is steadily evaporated and as steadily renewed by fresh supplies of cold water. It will be seen, then, that while the friction between the brake blocks and the wheel measures the resistance opposed to the motion of a piston, the actual energy—the work done—is represented by the heat transferred to the cooling water, and to the air by radiation and conduction. In a word, the brake does on a large scale what Joule did on a small scale when he determined the value of J by direct experiment. It is furthermore assumed that the frictional resistance to the rotation of the wheel must be the precise equivalent of the heat expended, and that for this reason the heat factor may be entirely disregarded, and the brake load and velocity in feet per minute alone considered. The weak point in the chain of reasoning is obviously this latter assumption. It is clear that the brake can and must record the minimum work done, but it is not clear that it must record the maximum work done. To make our meaning plain, let us suppose that two brakes are run under apparently identical conditions as to speed, load, &c., but that one heats a greater weight of water than the other in any given time. The natural conclusion is, undoubtedly, that the engine is doing more work in the latter case than the former. Of course the direct answer to this is that we have assumed an impossible state of affairs, and that in all cases, if the conditions are the same, the same weight of water will be heated. We say without the least hesitation that this is pure theory, and that experiments go to prove that the theory is not true. In a word, then, it seems to be possible for an engine to support a given brake load, and to expend variable amounts of power in supporting it. It will carry the load and do something else as well. Until it is proved that this assumption is unsound, doubt must attach to the results obtained from a brake. We should not put this proposition forward if we had nothing to support it; but there are beyond all question facts which are, we think, explicable on no other theory than that which we have briefly stated, namely, that the brake not only supports the weight, but does something else besides which absorbs energy, so that the actual work done by the engine may be in certain cases greater than the brake says it is. The only alternative lies in proving that the figures obtained during the engine tests in question are erroneous and misleading.

In the old days when the Royal Agricultural Society carried out brake trials, the competitors made long and elaborate experiments with their racing portable engines before they sent them to the showyard. These trials extended over months, and those who made them acquired enormous experience. The result was, that all the old hands maintained that there was a great difference in brakes, and that more mechanical hours could be run on a brake with the blocks in good order, and the wheel rim well polished, than could be got out of a brake with new or rough blocks, and a wheel rim at all out of condition. "A well-worn brake always gave the best results." "It ran cooler." Disputes and jealousies arose in the showyard as to the allotment of particular brakes to particular engines. We have heard it said that one brake "was ten minutes better or ten minutes worse" as the case might be, than any other in the showyard. In theory this kind of talk was all nonsense. So long as the brake load was all right there would be no difference to the engine. We in this case would back the experience of the men who made the racing of portable engines the business of their lives, against any amount of theory. They held that the brake work done by an engine might be in excess of that shown by the brake; they never dreamed of saying or thinking that it could be less. We have heard it argued that no doubt the Appold brake in bad or indifferent condition would consume more power, because it was unsteady and called the compensating levers into play, than would a similar brake in good condition; but that all this chance of error was eliminated by the rope. We stated at the outset that we should show that even the tail rope brake may give doubtful indications, and we can cite a very noteworthy instance of this. In another place will be found an account of the electric light installation at Oxford. We beg to direct the attention of our readers to the table which they will find on page 17, it will repay careful examination. Let us consider now what some of its figures mean.

The engine tested is of the triple-expansion type, made by Messrs. McLaren, of Leeds, and a very interesting and wholly instructive experiment was carried out, to test the value of steam jackets, and the engine generally for consumption of water and fuel. The tail rope brake was used. The first run was made without steam in the jackets; the second with steam. It will be seen that the consumption of steam was, within the limits of error of observation, precisely the same in both cases. Without steam in the jackets the engine used 13·7 lb. of feed-water, and with steam in the jackets 13·54 lb. of feed-water per indicated horse-power per hour. We have here, then, another experiment going to show that jackets really are of no service whatever to a good engine, and we commend the figures to Mr. Donkin's attention. Now let us see what the brake has to tell. During the first experiment without jackets the brake horse-power was 112·8, and the water per brake horse-power was 17·67 lb., and the efficiency of the engine was 77·67 per cent. But when the steam was admitted to the jackets the water per brake horse-power was 15·513 lb. only, and the brake horse-power was 106·85, and the efficiency rose to 87·35 per cent. The indicated horse-power without the jackets was 145·21, with the jackets 122·33. Neglecting fractions, we find then that without the jackets 145 indicated horse-power gave 113 brake horse-power, a difference of 32-horse power. When steam was admitted to the jackets, 122 indicated gave 107 brake horse-power, a difference of 15-horse power only. We have here the not inconsiderable amount of 17-horse power to be accounted for. What became of it? Many things have been claimed for jackets, but we never yet heard that they augmented efficiency as regards the relation between brake and indicated power.

The clue to the answer is, we think, given in the conditions of loading. Under the tail rope system the active load is hung at one end of a rope passed round the fly-wheel, and a spring balance is attached to the tail end of the rope. The pull of the balance is deducted from the live load; the remainder or net load is taken as the basis on which to calculate the power. The spring balance is only used to keep the rope tight on the wheel, so that sufficient friction may be established to enable the wheel to carry the weight. Now, during the first trial without jackets, we find that the live load was 1014 lb., and spring balance pull 70 lb., leaving a net load of 944 lb. But when the jackets were used the live load was only 946 lb., and the tail rope pull only 4·77 lb., leaving the net load 941·23 lb., or practically the same in both cases. If, now, the manner of loading had no effect on the brake, there is no reason why there should be any difference worth mentioning between the two efficiencies. A close examination of all the figures given in the tables fails to supply a hint or suggestion of a reason why 17-horse power should be wasted. It is true that the engine ran about 5 per cent. faster in one case than the other, Different indicators were used also, on the 19th and 21st of January; but no deduction can be drawn from this, as no doubt care had been taken to verify both. The only admissible conclusion is that during the first experiment the engine not only carried the brake load, but did something else as well, and that something was done because the cord was very much tighter on the wheel in the first than in the second experiment. Only those who have tried can form an adequate idea of the way in which the grip of the rope on the wheel is augmented by a very small addition to the tail weight. No doubt in the first experiment the rope was lubricated, and in the second it was not. It remains to be seen whether or not Messrs. McLaren can add anything which will explain what became of 17-horse power entirely unaccounted for in the report.

We wish it to be very clearly and definitely understood that we do not assert that a friction brake must necessarily give erroneous results. All that we wish to do is to draw attention to the fact that the tail rope brake, or any other brake, is not necessarily infallible; that contradictions and anomalies are met with in its performance, and that, like any other instrument of precision, it must be used cautiously, and with skill and judgment. The extraordinary way in which a rope will sometimes run cool and sometimes hot under apparently precisely the same conditions cannot fail to have struck every one who has used a rope brake. All these things occur from adequate causes, and it is worth while to find out what they are. We venture to assert that if Messrs. McLaren's engine had been tested under the same conditions of brake load with and without the jackets, they would not find that 17 horse-power had disappeared, no one can say how or where.

THE CENTRAL LONDON ELECTRIC RAILWAY BILL.

IN connection with the proposed electric railway schemes before the late Parliament, not the least important among them is the Central London Railway (Liverpool-street Extension) Bill, which, by the time this appears before our readers, will have passed into an Act, owing to the withdrawal of the opposition of the City Commissioners of Sewers to the proposed acquisition by the company of certain parts of the public way in the large open space in front of the Mansion House for entrances and staircase down to the proposed public subways to be constructed 10ft. under ground in connection with its Mansion House station. These subways are to be for the common use of pedestrians crossing this dangerous thoroughfare, and will also be the means of getting down to the company's station by lift, some 70ft. lower. The opposition of the Commissioners arose because they could not see their way clear to part with so much public space as would be required to form the eight entrances to these subterranean ways. However, a special meeting recently requistioned has been held to discuss the whole question, with a view to coming to a definite decision. At the meeting, which was a full one, a report was read from the Finance and Improvement Committee, dated May 31st, and signed by nine members. The Remembrancer and the solicitor were both heard, and after the consideration of the report, Mr. J. C. Bell, C.C., moved its adoption, expressing regret at the fact that every member of the Commission was not present, as he regarded this as the most important and most momentous question ever brought before them. The Committee had had a model of the proposal before them; he trusted they would agree to the report of the Finance and Improvement Committee, as the company was willing to defray the entire cost of the subways, which, needless to say, would be very great. Mr. W. H. Pannell seconded. He said that the Committee were practically unanimous in their recommendation. What they had to ask themselves was, how far can we apply this scheme to our own purposes, and relieve the congested state of the traffic of the City? "It is as manifest to you," said the promoters, "as to us, that we must have a station in the City. If we take this new line, we avoid the Cornhill station, and we suggest that it would be more convenient for us to have a station near the Mansion House. This is the price we will pay you if you will support all this change of front on our part of last year. We undertake to make the approaches to our station underground, yet at the same time to make, free of cost to you, these very convenient subways for crossing that area under the control, and under the direction of your own engineer." The estimated cost of these subways is between £50,000 and £60,000. It was then resolved that the Court agree with the Committee in their report, and that it be referred to the officers accordingly. It was also resolved "That the officers be authorised to retain the necessary witnesses," &c., and "That the officers do endeavour to obtain the utilisation of the central railway station at the Mansion House by the three proposed underground electric railways, *i.e.*, Central London, City and South London, and Waterloo and City." Thus this vexed question that was threatening to wreck the Central London Railway Bill has been amicably settled, as also the question that generally crops up at the meetings of the Commission like an "hardy annual," viz., the question of forming underground subways at the Mansion House. It is understood that not only are these underground subways to be made under the control and direction of the City Engineer, but after completion they are to be placed under the control of the Commissioners entirely. Borings, under the Act of last year, will be speedily commenced. A description of the proposed works will be found in our impression for May 27th, page 459.

BORING FOR WATER.

ONE the bulletins of the American Census Office just issued is by Mr. F. H. Newell, a special agent of that office; and it is devoted to the question of artesian wells for the purpose of irrigation. In the western half of the United States there are no fewer than 8097 of such artesian wells, in which there was invested, it was estimated, about £400,000. A large number of these wells—over one-half of those used for the purposes of irrigation—are found in the State of California, where 38,378 acres of land are "irrigated by artesian water." This industry is described in the report we have referred to as properly to be "considered a branch of mining." It is comparatively a new industry, for though there are cases of wells that have been flowing for twenty or even thirty years, yet the greater number by far have been put down within the last decade. The success that has been attained in California, we are told, has led to many efforts elsewhere to secure flowing water. Railway companies have drilled for pure water at various spots along their lines, and cities and towns have devoted money for experimental borings. In one of the counties in California—in Kern County—there are no fewer than 388 artesian wells, the depths varying from 50ft. to 1200ft. A land company has twenty-four artesian wells, and some of these are said to yield about 2,500,000 gallons per day, whilst the flow from others is very limited. The figures that have been given are collected by the Census Office from the owners of the wells; and it is added that the result of the examination of the returns from all the area shows that each well irrigates on the average 13·21 acres, and that the average cost of water per acre irrigated is about £3 13s. The report raises a very interesting subject, not only as to the cost of the method of boring artesian wells, and the consequential cost of the water that they yield, but also the important question of the relative cost of different methods of storing water for use, and the endurance of the supplies of water that the artesian wells yield. To a country circumstanced as is the United States there are questions that are of paramount importance, but they have their relative value here, especially at a time when the great towns have year by year to increase their water supplies, and to go further and further afield to do so. California, as one of the States that is most dependent on such a supply, may give to us very valuable information on "mining for artesian waters," and may give to districts in this country very useful examples.

MILLING AND BAKING EXHIBITION.

MORE than eleven years have elapsed since the first great exhibition of milling machinery was held at Islington. Then gradual reduction and roller flour milling were comparatively new to this country, and the demand for pure white flour was not so keen as it is now. We were just getting discontented with the dirty appearance of household bread and were looking for something more refined. Since 1881 a vast number of new flour mills with complete roller plants have been built and numbers of old mills converted from stone mills to roller mills, and for this a new industry in the manufacture of the roller mills, and other machines required for the new process, has sprung up and settled down into a steady trade. In 1881 the manufacture of these special machines was quite in its infancy in this country. The milling engineers then contented themselves with importing chilled rolls from Germany, Austria, and Switzerland, and fitting them into frames of their own make, or even importing the machines ready for work. This latter remark applies not to roller mills alone but to the other machines, purifiers, centrifugals, and the like, necessary for the new process. At the present time there is a large number of makers of chilled rolls, purifiers, and centrifugals, and special plant has been put down for casting, turning, grinding, and fluting the rolls, of which large quantities are being turned out. The Exhibition of 1881 was just at the time when this new industry was starting, and was closely followed by the present great development of this highly specialised industry. Considering this, we are surprised to find that so many English milling engineers have turned their backs to the golden opportunity afforded by this exhibition to show the excellence of their manufactures, and to meet their customers the millers, and hear from them and from one another remarks which they can alone hear at such public exhibitions, and which must render them material service, and prevent both maker and user from falling into a narrow groove of their own advertised excellence. One result of exhibition has always been to stimulate a desire for increased general excellence, both in design and workmanship and fitness for the work required to be done; any doubtful factors in a machine about which even other than makers might ask awkward questions, are carefully avoided in machines for

exhibition. The present exhibition is not very extensive but probably when we come carefully to examine the exhibits we shall find many useful improvements. One good feature is that most machines will be working every day, some being driven by gas engines, some by steam engines, and opportunities will thus be afforded of making examination of their action. Amongst the exhibits of baking machinery there are ovens, kneading machines, biscuit machines, and others. We notice a quantity of wire cloth, a loom for weaving the same, and several exhibits of milling sundries.

LITERATURE.

Transactions of the Royal Irish Academy.—On Elliptographs and on a Mechanical Rocker for Detecting Oscillations. Vol. xxix., Part xix. By THOMAS ALEXANDER, M.A.I., Professor of Engineering, Trinity College, Dublin, and A. W. THOMSON, D.Sc., Professor of Engineering, Science College, Poona. 1892.

A NOTABLE simplification of the ordinary elliptic trammel is given here by the authors, consisting in the suppression of one of the slots and sliding pieces, the requisite restraint being now supplied by a bar connecting the point midway between the two sliding pieces of the old system with the point of crossing of the slots, the centre of the ellipses. If considered necessary, the single remaining slot and sliding piece could also be suppressed, and the corresponding point made to assume its rectilinear motion by means of the constraint of a Peaucellier parallel motion.

Mr. Penrose, the architect of St. Paul's, has employed a modified form of Peaucellier's motion for setting out circular curves of large radius, as required, for instance, in the steps at the west front of St. Paul's. The present instrument may also prove of practical value in architecture, engineering, and engraving, where it is required not only to set out elliptic arcs, but also to cut out the actual material, stone or iron or copper, by a good, heavy cut, which the pivotted joints and the absence of backlash from sliding pieces would enable it to do.

Another important addition made by the authors enables their machine to be used in this way for cutting purposes. This consists in a steering needle or tiller, which guides the pen or cutting tool in the direction of the tangent. The steering needle is compelled to assume the direction of the normal of the ellipse by passing through a hole in a pivot which is fastened at a point in the prolongation of the central radial bar, at a distance from the centre which is double the distance of the pivot in the describing bar. A diagram would show immediately the geometrical reason for this and the other properties. The same mechanical principles are used for the illustration of Rankine's ellipse of stress, and also for other elliptographs for the continuous description of ellipses of every excentricity. The mechanical rocker is an application of the same kinematical principles for detecting earthquake shocks, and can be applied to scaffolding and fire escapes. An appendix on the dynamical investigation of the period of oscillation of the rocker by Professor Tarleton is elegant, but of purely mathematical interest.

An Introduction to the Differential and Integral Calculus. By W. J. MILLAR, C.E. Third edition. Blackie and Sons.

IN the short compass of these sixty-four pages the author has contrived very ingeniously to present a working knowledge of the notation and methods of the elements of this important subject, now indispensable to engineering and electrical students, so as at all events to overcome the terror of the two sacred symbols of operation—the little d and the long $\int$.

Having proved a general principle of differentiation or integration, the author proceeds immediately to drive it home with a well-chosen application, such as the bending moment of a beam, the moment of inertia of its cross-section, or of a shaft or fly-wheel, and the work done in an indicator diagram by the hyperbolic isothermal expansion of steam.

We think his diagram on page 18, of the position of the crank when the piston velocity is a maximum, should be re-drawn for a subsequent edition in accordance with Mr. Macfarlane Gray's views, given recently in our columns. Again, the discussion on page 51 of the strength of a hydraulic press—or of a gun—proceeds on the assumption that the circumferential tension varies inversely as the distance; whereas Barlow's law of the inverse square, modified according to Rankine by an additive constant, is the law universally accepted for artillery.

A well-selected collection of examples need not occupy more than a couple of extra pages, and would add considerably to the value of the book, in giving the student an opportunity of testing the soundness of his knowledge.

BOOKS RECEIVED.

Reference Book for Marine Engineers and Naval Architects. Arranged by Hedley Oliver, C.E., N.A. Liverpool.

Longmans' School Mensuration. By Alfred J. Pearce, B.A. (Inter.), Hons. Matric. (Lond.) London: Longmans, Green, and Co. 1892.

Everybody's Pocket Cyclopædia of Things worth Knowing, Things difficult to Remember, and Tables of Reference. By Don Lemon. London: Saxon and Co.

Travels amongst the Great Andes of the Equator. By Edward Whymper. With maps and illustrations. Second edition. London: John Murray. 1892.

Adressbuch und Waarenverzeichniss der Chemischen Industrie des Deutschen Reichs. Herausgegeben von Otto Wenzel. 1892. III. Jahrgang. Berlin: Verlag von Rudolf Mückenberger, Dessauerstrasse 13.

The Alternate Current Transformer in Theory and Practice. Vol. II.: The Utilisation of Induced Currents. By J. A Fleming, M.A., D.Sc. (Lond.) London: *The Electrician* Printing and Publishing Company. 1892.

The Great Eastern Railway Company's Tourist Guide to the Continent. Edited by Percy Lindley. Illustrated. New edition. Published for the Great Eastern Railway Company. London: 30, Fleet-street, and 61, Regent-street.

ON THE PROBLEMS OF STEAMSHIP PROPULSION.

By ROBERT MANSEL, Glasgow.

FOR many years, I have striven to obtain the recognition and proper application of two of the most important fundamental propositions of mechanical science. First: the one enunciated by Sir Isaac Newton, as a scholium to the Third Law of Motion. By which is declared, in the use of all kinds of machines that there is necessary equality between the gross sum of the works done on the several resistances, and the gross power developed to do the work. Secondly: the late M. Morin's deduction, as to a constant diminution of the gross piston pressures, which virtually occurs with every engine developing power, and under similar conditions, doing work at varying rates of speed. It being understood, each machine has its own special value of this quantity, which remains constant, so long as the circumstances of trial remain *exactly* the same.

A steamship is a machine to which these propositions are directly and peculiarly applicable. It is not difficult to show, while nominal attempts have been made to apply Newton's deduction, this has been done under misapprehension of the true meaning, and in such a manner: the deductions arrived at, are in direct contradiction to the principle which they were supposed to explain and illustrate. Proposed methods of reconciliation have, likewise, been mistaken assumptions, which only further obscured the true relation of the elements and issues of the involved problems. Morin's principle, again, has been equally misunderstood; or, rather, is better described, as having been entirely ignored.

Restricting the question to an important fundamental one, viz., the relation of the gross power E, and speed of vessel V. I have repeatedly shown that the answer implies two conditioned constant quantities a and b, the simple relation of the whole being:

(1) . . . . . $E = b\,V\,10^{a\,V}$,

which expresses a physical principle. Power expended in doing work produces mechanical effects, which are measured, by the product of the quantity factor b V into the intensity factor $10^{a\,V}$. The speed of the vessel enters this latter, *not as hitherto assumed:* the resistance is a quantity following a parabolic law, and entering the formula as a factor of the form V^n. The true law is, as follows: the speed, modified by a coefficient, enters the resistance as an exponent. The revolutions, speed, and two constant coefficients furnish another exactly similar equation:

(2) . . . . . $N = m\,V\,10^{n\,V}$,

by which, modifying the preceding formula gives:

(3) . . . . . $E = C\,N\,10^{(a-n)\,V}$,

a singularly important formula, the initial coefficient of the second member having the value:

(4) . . . . . $C = \frac{d^2\,s}{21{,}010}\,f$,

where d and s denote the diameter and stroke of the high-pressure piston, and f the value of Morin's constant for the particular trial's circumstances. Hence, as may be readily seen, $C\,N = \frac{d^2\,s}{21{,}010}\,f\,N$ simply expresses the work done at the speed of piston, upon a resisting pressure f, equal to Morin's constant, the result being stated in Watt's horse-power units. Hence the mechanical principle that the power expended in propelling a vessel, under similar conditions at various speeds, varies as the products of the works done on Morin's constant, at the respective speeds of piston, each multiplied by an exponential factor of the form $10^{(a-n)\,V}$. The quantities a and n satisfying the conditions implied by the formulæ (1) and (2). In a slightly varied form, a steam vessel, free to move and with the engine shaft making N revolutions per minute, when developing power at the rate E indicated horses, applied to the vessel's propulsion, will have the speed V nautical miles per hour, provided two constant quantities or coefficients, C and c, are related to the variable elements, by the simple relation

(5) . . . . . $E = C\,N\,10^{c\,V}$.

(Designate C and $c = (a - n)$ by the names: the initial and exponential coefficients, respectively.)

Subject to explanations, every set of trial data of actual steam vessels confirms the statements advanced. I append the calculated values in a large number of illustrative cases, from trial data of steam vessels of the Royal Navy, as follows:—

TABLE I.

Names of vessels.	Initial coefficients. C	Exponential coefficients. c
H.M.S.S. Philomel	4·504	·0524
,, Melpomené	4·277	·0607
,, Iris V. set	5·843	·0625
,, Edinburgh	6·263	·0688
,, Iris IV. set	3·93	·0707
,, Edgar	4·33	·0710
,, Blenheim	6·75	·0710
,, Hecla	4·667	·0716
,, Rattlesnake	·3424	·0743
,, Raleigh	5·605	·0756
,, Shah	6·362	·0763
,, Imperieuse	5·542	·0771
,, Himalaya	3·470	·0810
,, Opal	1·915	·0810
,, Heroine	1·120	·0840
,, Hercules	7·300	·0826
,, Nelson	5·094	·0855
,, Warrior	5·910	·0858
,, Bacchante	3·150	·0900
,, Galatea	1·459	·0918
,, Anson	·4584	·13775

With the values of such coefficients, the general equation, in suitable shape for practical use, by equating the logarithms of its members, gives; for any proposed case, an exceedingly simple calculation. For example,

H.M.S.S. Melpomené, $E = 4{\cdot}277\,N\,10^{\cdot0607\,V}$.

Or, again, $\text{Log. } E = {\cdot}6311 + \text{Log. } N + {\cdot}0607\,V$,

So that, if by observation, N = 143·6, V = 19·7, and, again, N = 128, V = 17·383 the calculated values of Log. E, for these conditions, are:—

		H.M.S.S. Melpomené.	
	Log. 4·277 =	·6311	·6311
Add	Log. N =	2·1572	2·1072
,,	·0607 V =	1·1958	1·1552
Sum, or	Log E =	3·9841	3·7935
∴	E =	9641	6216 same as given by trial data.

Again, to illustrate another problem. By the table, we should have:—

For H.M.S.S. Blenheim, $E = 6{\cdot}75\,N\,10^{\cdot071\,V}$.

or, $\text{Log. } E = {\cdot}8293 + \text{Log. } N + {\cdot}071\,V$.

With the observed values of E and N, what are the true corresponding values of V? Obviously, the formula is, $V = \frac{1}{\cdot071}\left(\text{Log.}\frac{E}{N} - {\cdot}8293\right)$.

Observed values of	N =	39·0	50·0	66·0	84·0.
,, ,,	E =	1028	2079	4877	9758 I.H.P.

		H.M.S.S. Blenheim.				
We have,	log. N =	1·5911	1·6990	1·8195	1·9243	
Add,	log. C =	·8293	·8293	·8293	·8293	logs. of:
	Sum =	2·4204	2·5283	2·6488	2·7536	work on Morin's constant.
Since,	log E =	3·0120	3·3179	3·6882	3·9894	gross power,
	differences =	·5916	·7896	1·0394	1·2358	ratios of ditto.
Next, we have,						
	logs differences =	−1·7720	−1·8974	·0167	·0920	
Subtract	log. ·071 =	−2·8513	−2·8513	−2·8513	−2·8513	
	Logs. V =	·9207	1·0461	1·1654	1·2407	
	∴ V =	8·331	11·12	14·64	17·41	nautical miles.
By trial data	V =	8·334	11·00	14·64	18·00	nautical miles.
	Differences =	− ·003	+ ·12	·00	− ·59	

It will be obvious: the agreement of the formula with the trial data, in the three lower speeds, is very close, differences not exceeding what might be expected, from inevitable slight insufficiencies of observation and calculation. The highest speed, however, shows a larger and inadmissible difference, most probably an indication of a remarkable phenomenon, which cannot fail to force itself on a thoughtful investigator, viz., the quantity f, known as Morin's constant, is not an absolute but a conditioned constant, which changes its value at special speeds, in all screw vessels. Thus the coefficient $C = \frac{d^2\,s}{21{,}010}\,f$, necessarily varies directly as f, and c varies in sympathy with it, but in an inverse ratio, the law of which has not been sufficiently investigated. I have repeatedly called attention to and given illustrations of this.

TABLE II.—*Examples of Critical Speeds and Changes of Coefficients.*

Names of vessels.	Speed limits. knots.	Initial coefficients.	Exponential coefficients.
British torpedo launch	under 17·6	·0438	·070
,, ,, ,,	over ,,	·1258	·044
French ,, ,,	up to 10·20	·0580	·085
(Note the two changes)	10·20 to 16·80	·0885	·067
(Data by M. de Bussy)	over 16·80	·2536	·0402
Sunderland ,, ,,	under 18·65	·7482	·0314
,, ,, ,,	over ,,	·1495	·0690
U.S.N. Vesuvius	under 18·9	·649	·05862
(Data by Mr. Cramp)	over ,,	·1367	·0944
H.M.S.S. Prince Consort	under 12·12	10·180	·05753
,, ,,	over ,,	2·248	·1162
,, Collingwood	under 16·046	5·297	·0744
,, ,,	over ,,	1·709	·1050
Italian R.N. Lepanto	under 15·16	6·81	·0838
,, ,,	over ,,	18·49	·0528

Some years ago: an extensive and instructive set of experiments upon H.M.S.S. Iris, were communicated to the Institution of Naval Architects by Messrs. White and Wright, of the Admiralty. These illustrated the marked effect upon the speed capability, and efficiency, of the same vessel, under similar conditions, when variations were made upon the constructive details, and dimensions of the propellers. I have quoted in Table I. the results of the IV. and V. set of these, by which we see:—

H.M.S.S. Iris, set IV. $E = 3{\cdot}93\ N\,10^{\cdot0707\,V}$. Hence $f = 8{\cdot}187$

H.M.S.S. Iris, set V. $E = 5{\cdot}843\,N\,10^{\cdot0625\,V}$. Hence $f = 12{\cdot}170$

The ratio of the values of f, being the same as that of the initial constants of the second members.

Let us recur to equation (1): $E = b\,V\,10^{a\,V}$. And, instead of modifying by (3): by following out Newton's deduction, we arrive at the form:—

$$E = \frac{D^{\frac{2}{3}}}{10^{a\,X}}\,V\,10^{a\,V} = D^{\frac{2}{3}}\,V\,10^{(V-X)\,a}.$$

In the foregoing cases, reducing to:—

H.M.S.S. Iris IV. $E = 128{\cdot}9\,V\,10^{(V\,-\,11{\cdot}795)\,0734}$.

H.M.S.S. Iris V. $E = 128{\cdot}9\,V\,10^{(V\,-\,10{\cdot}423)\,0662}$.

By which, calculate the powers respectively, for 18, 15, and 10 knots.

	H.M.S.S. Iris IV.			*H.M.S.S. Iris V.*		
Speeds V	= 18·0	15·0	10·0	18·0	15·0	10
Values X	= 11·795	11·795	11·795	10·423	10·423	10·423
	6·205	3·205	−1·795	7·577	4·577	−·423
Then (V − X) a =	·4555	·2353	− ·1318	·5016	·3030	−·0280
Add, log. V =	1·2553	1·1761	1·0000	1·2553	1·1761	1·0000
,, log. $D^{\frac{2}{3}}$ =	2·1103	2·1103	2·1103	2·1103	2·1103	2·1103
Sum, or log. E =	3·8211	3·5217	2·9785	3·8672	3·5984	3·0823
∴ E =	6624	3324	952	7366	3885	1209 [I.H.P.

Here, definitely stated, are the results of an alteration of propeller: f has changed from 8·187 to 12·170, in sympathy with which we have the changes of coefficients of the formulæ:

$$E = \frac{d^2\,s}{21{,}010}\,f\,N\,10^{(a-n)\,V} = \frac{D^{\frac{2}{3}}}{10^{a\,X}}\,V\,10^{a\,V} = D^{\frac{2}{3}}\,V\,10^{(V-X)\,a}$$

In which D denotes the displacement, and X the quantity which I name the subdominant speed, satisfying the condition: when (V − X) = 0, obviously: $E = D^{\frac{2}{3}}$.

Also, note particularly: the second form, viz., $E = \frac{D^{\frac{2}{3}}}{10^{a\,X}}\,V\,10^{a\,V}$, is the true form of the equation, improperly written, $E = \frac{D^{\frac{2}{3}}}{C}\,V^3$, and with its analogues named "Admiralty Formulæ."

The corrections being: C should be $10^{a\,X}$, $D^{\frac{2}{3}}$ more nearly, $D^{\frac{2}{3}}$, and the resistance proportional to $10^{a\,V}$, and not V^2, as usually assumed.

ELECTRIC LIGHTING IN OXFORD.

On Saturday, June 18th, the electric current was switched on for the first time to the City of Oxford, by the Oxford Electric Company, and a large party had been invited to a dinner given at the works in honour of the occasion. The arrangements were very satisfactorily made by Mr. Geo. Offor, the secretary of the company. We have referred previously in our issue of April 1st last to some of the features of the system employed, and are now able to give a full description of the plant.

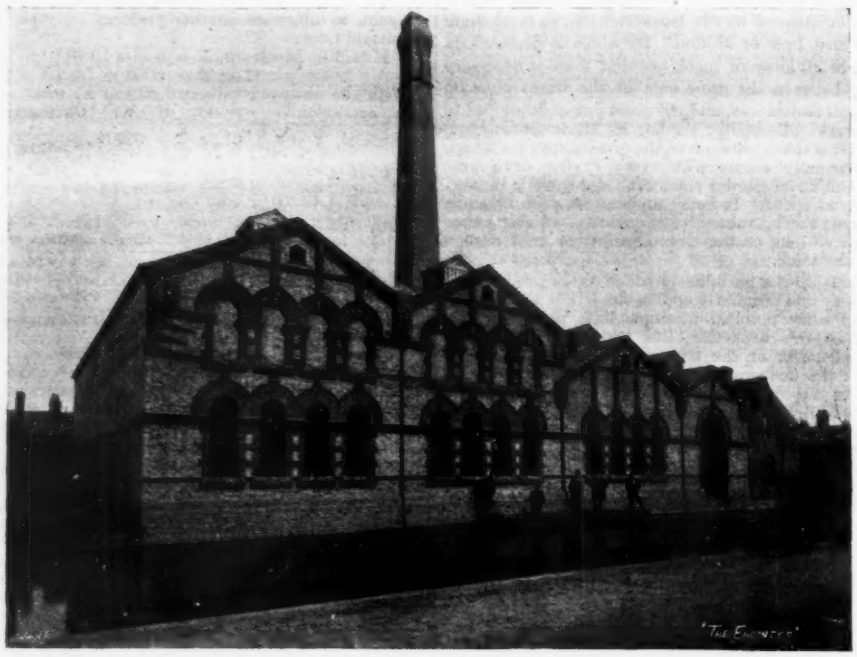


Fig. 1—OUTSIDE ELEVATION OF CENTRAL STATION AT OXFORD

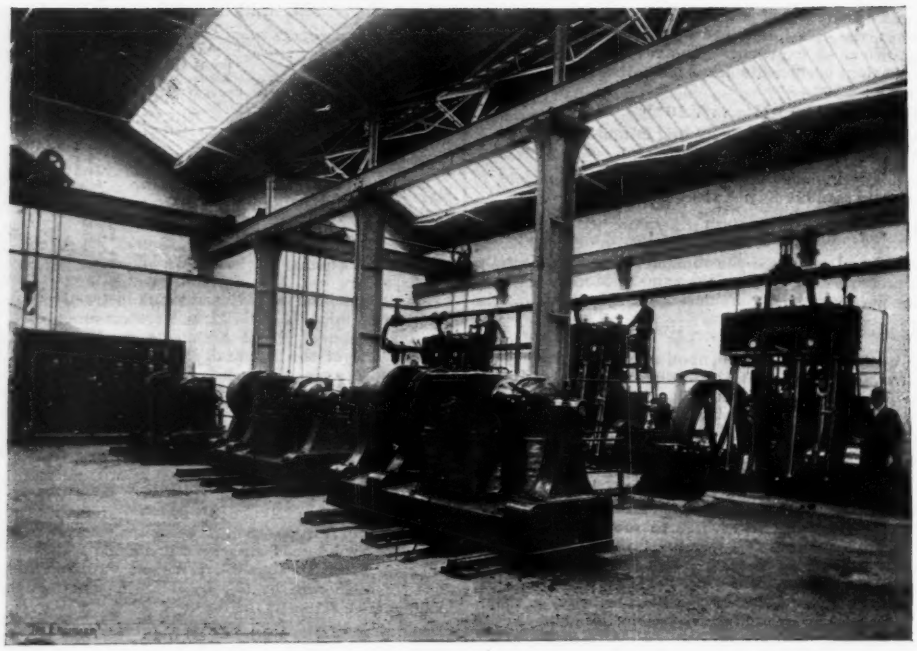


Fig. 2—INTERIOR OF ENGINE ROOM, OXFORD CENTRAL STATION

It was found impossible to obtain a suitable piece of ground for the works near the centre of the city, a piece of land was therefore acquired at Osney upon the banks of the river Isis. The outside of the buildings, which are of a neat design in brick, is shown in Fig. 1. The interior of the engine-room is shown in Fig. 2, from which it is evident that there is ample room for more plant. This position will enable the company to charge electric launches, which will be an important source of revenue, and the works are kept away from the better parts the town.

The system adopted is that of high-tension continuous currents, with dynamotors or current transformers, which produce currents of low pressure for the network. The dynamos at the generating station produce the current at a pressure of 1000 volts, and this is transformed down at the sub-stations to a pressure of 100 volts.

Fig. 3 is a plan of the part of the city in which the sub-stations are placed, and the mains already laid along the streets are shown. The contractors for the whole work are the Electric Construction Corporation, of Wolverhampton, and it has been carried out under the supervision of Mr. Thomas Parker, the managing director. The building is a well-built structure of brick, designed by Mr. Brevitt, of Wolverhampton, and the builders were Messrs. Kingerley, of Oxford. It is divided into two main sheds, separated by a brick wall. The engines and dynamos are placed in one part, and the boilers in the other, and all the plant is on the ground level. The engine-room is thus kept perfectly free from coal dust.

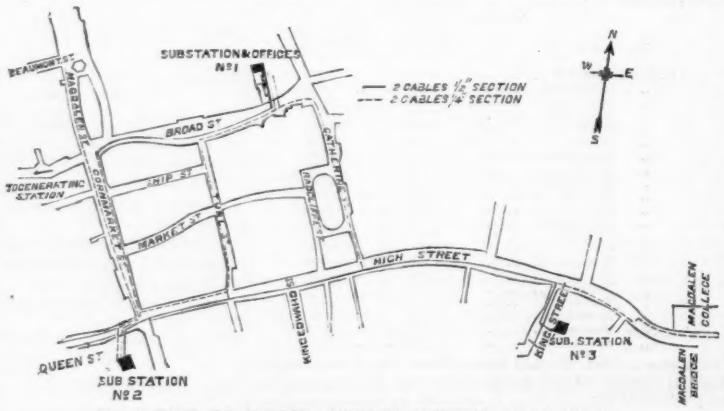


Fig. 3—PLAN OF OXFORD, SHOWING ELECTRIC LIGHT MAINS

Three steel boilers of the locomotive type are at present installed; these were all built by Messrs. J. and H. McLaren, of Leeds; a Green's fuel economiser is placed in the main flue, and a suitable by-pass is arranged so that gases may pass direct to the chimney if needful.

The engine-room is well lighted from above. The steam pipes are arranged upon the ring system, so that in case of breakdown as little as possible of the plant would be affected. Stop valves are placed between each two engines, and the bends are all of copper. Three engines are now put down, and these are of the inverted triple-expansion type shown on page 5, built by Messrs. J. and H. McLaren and Co. By the courtesy of the makers we are enabled to give the results of tests which were carried out at the works by Mr. Wilson Hartnell, Professor Goodman, and the inspecting engineer, Mr. Watson. The sizes of the cylinders are:—High-pressure, 9in. diameter; intermediate, 14·25in.; low-pressure, 22·5in. diameter, by 24in. stroke. Two trials were made, in one of which it will be observed the steam jackets were used, and in the other were not used.

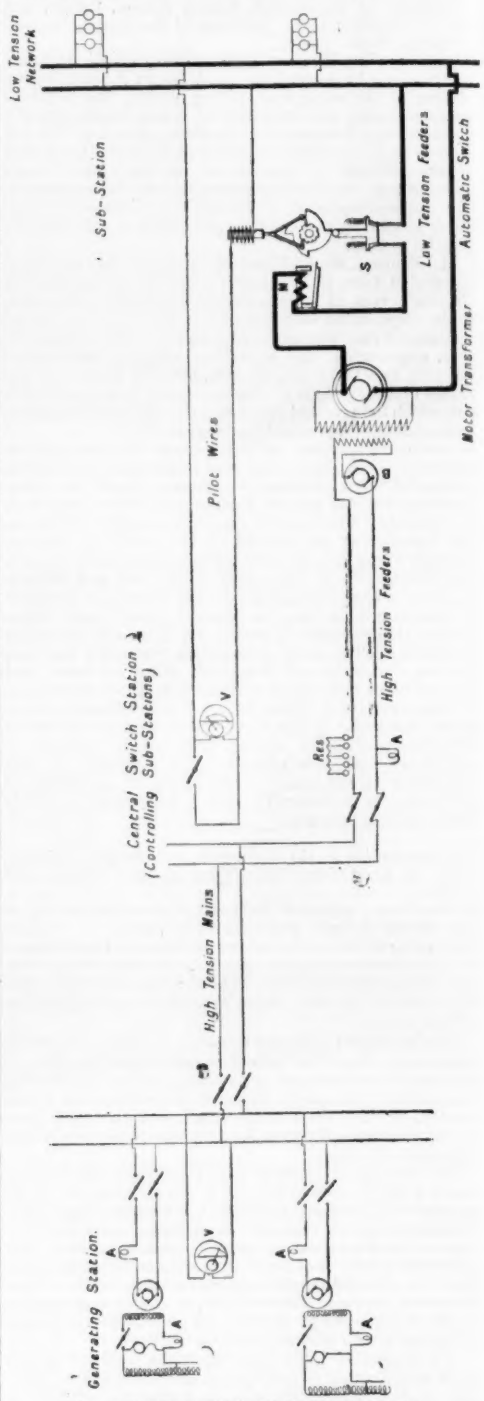


Fig. 6—DISTRIBUTION BY TRANSFORMERS

We may add, that the high-pressure and intermediate cylinders are jacketted with steam at boiler pressure, and are drained through a McDougal steam trap into the hot well. The low-pressure cylinder is not jacketted. The McLaren automatic governor is placed inside the fly-wheel upon the shaft itself, and it works direct on to the high-pressure slide valve, which is not balanced in any way. The governor is self-locking, and is therefore not affected by any friction on the slide valve. The engines run very steadily, and all danger of the governor being put out of gear by the breaking of a belt is obviated. The surface condenser is fitted with brass tubes and tube plates; the tubes are $\frac{3}{4}$in. outside diameter, and there is 382 square feet of cooling surface. The air pump is 11$\frac{1}{2}$in. diameter, the circulating pump 10in. diameter, and the feed pump 1$\frac{3}{4}$in. diameter, all three having a stroke of 14in. The pumps are placed behind the condenser, and are worked by levers from the intermediate engine. The crank shaft is of forged steel, 5$\frac{1}{2}$in. diameter, the crank pins 5$\frac{1}{2}$in. diameter, and the engines are thoroughly well finished. Each of these engines is provided with a heavy fly-wheel, and drives a dynamo by means of belting; two of the belts are of the usual double-sewn type, and the third is a Gaskin link belt. The three dynamos—one of which is shown in Fig. 4—are all similar, and were built by the Electric Construction Corporation; each developes 1080 volts and 80 ampères, when running at 400 revolutions per minute. The dynamos are

provided with an extra bearing outside the driving pulley, and each is excited by a small Elwell-Parker dynamo, driven from a rope pulley keyed on to the shaft of the main generator. The exciters give 135 volts, and can thus be used to charge the accumulators which are used for lighting the central station. The electro-motive force of the dynamos can be regulated from 1100 volts at full load to 1000 volts at light load, by means of resistances placed in circuit with the exciters.

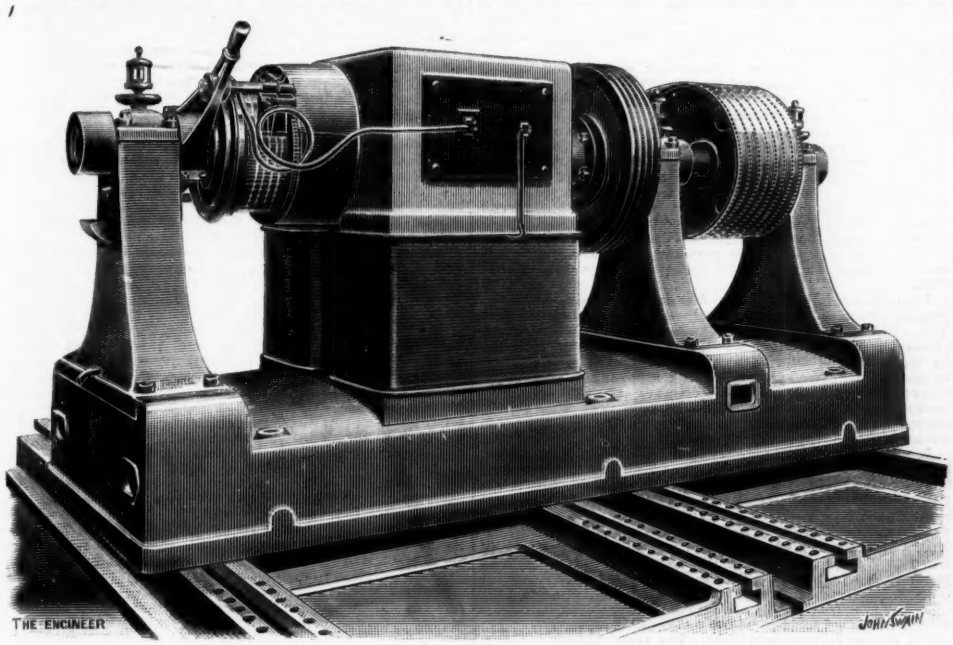


Fig. 4—1000 VOLT CONTINUOUS CURRENT DYNAMO

In the circuit of each dynamo is placed a double pole automatic cut-out—shown in Fig. 5—which protects the dynamo in the event of any excessive current, and is re-set by hand, but it is so arranged that the cut-out cannot be held on. The dynamos are all connected in parallel to two common omnibus bars upon a switch-board at the works.

The foundations for the engines are of a solid block of concrete, and that for the dynamos another solid block, weighing about 100 tons each, and about 11ft. deep. Air spaces are left around the blocks to diminish vibration.

The switch-board at the works is very simple, and consists of three panels, each of which is similar to Fig. 5, and carries one ampère meter for the high tension circuit, one for the exciter circuit and the knocking-off switch previously alluded to.

Two overhead cranes, each capable of lifting six tons, are provided in the engine-house, and a battery of fifty-three E.P.S. cells is used for the lighting of the station. By means of this battery and of that at the chief sub-station, it is possible to shut down altogether at the works for six to eight hours in winter, and twelve to sixteen hours in summer. At the time of our visit, Mr. McLean, the engineer in charge, had placed a dynamotor in the works in order to light up about five arc lamps of fifteen ampères each, and 370 eight candle-power lamps. Current was also supplied for the electric cooking, which formed a feature of the dinner. From the generating station run out two pairs of heavily insulated Silvertown cables, each consisting of 37/14 copper wires; these are laid in cast iron pipes, and are carried a distance of about one mile to the distributing station at Broad-street marked No. 1 on the plan, Fig. 3.

The system of working is clearly shown in diagram—Fig. 4—which we published in a previous issue. It will be seen that the dynamos are coupled to two omnibus bars at the generating station, and thence run the high-tension mains to the central switch station, whence all the other sub-stations are controlled. At each of the stations, Nos. 1, 2, and 3 on the plan—Fig. 3—is placed a dynamotor, such as shown in Fig. 7, which transforms the pressure from 1000 volts to 110 volts, and gives out a current of 360 ampères when fully loaded. The efficiency of these machines is very high, being 92 percent. when fully loaded, 89 per cent. at three-quarters load, and 87 per cent. at half-load. The main

FIG. 5.

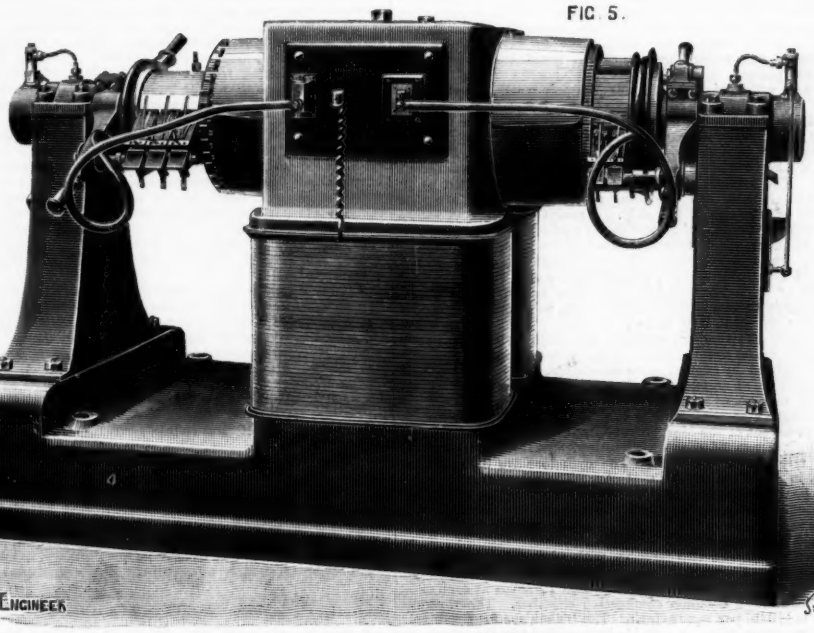


Fig. 7—ELWELL-PARKER DYNAMOTOR

winding is a shunt to the low-tension side, and there are a few turns on the magnets in series with the high-tension armature. The oiling arrangements are very complete. The end of the armature shaft is provided with a cam, which actuates the piston of a small oil pump which feeds the bearing; the oil passes away through a filter to the oil reservoir, and is used over again. It is thus possible to run for some days without attention. The brushes upon the commutator are of copper gauze.

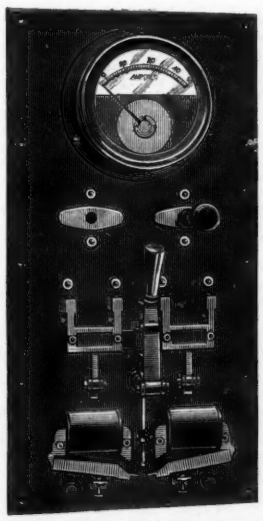


Fig. 5—Double-pole Automatic Cut-out

An accumulator of 114 cells of the L. 31 E.P.S. type is installed here, and the cells are arranged in four groups, two of thirty-eight cells and two of nineteen cells. They are charged in three groups of thirty-eight cells each, and are discharged in two groups, each consisting of thirty-eight and nineteen cells in series, and are capable of supplying a current of 120 ampères for eight hours.

Voltmeters are provided at the central switch station, which show the pressure at each of the sub-stations, and all the transformers can be controlled by one man. In starting a transformer the high-tension circuit is first closed through a resistance in order not to injure the armature windings. The dynamo field is then excited by a few coils in series. The dynamo part then begins to produce current, and the resistance is gradually taken out of the high-tension circuit.

In order to put the transformer into circuit with the low-pressure network, a special apparatus has been designed, shown in the diagram and also in Fig. 8; this instrument is placed at the sub-station and is designed for 400 ampères. It consists of a long-pull electro-magnet, which actuates a ratchet wheel and controls the switch. It is actuated by merely closing and opening a switch which short-circuits the voltmeter on the pilot wire. One of the wires to the voltmeter is wound round the long-pull magnet, and the feeble current passing to the voltmeter under ordinary conditions is not sufficient to attract the armature, but by

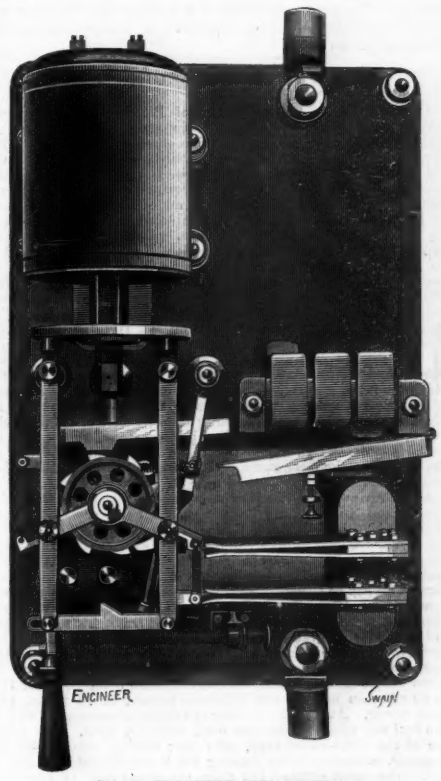


Fig. 8—TRANSFORMER SWITCH

closing the switch the voltmeter is cut out of the circuit, and the long-pull magnet acts; the switch is then opened, the heavy armature drops, and the double movement causes the switch which connects the low-tension network to the transformer to close. In cases of accidental overloading, an automatic cut out—shown in Fig. 5—opens the circuit.

The present capacity of the entire plant is 12,000 lamps of 32 watts, and 15,000 lamps could be wired.

Engine Tests.

	Jan. 19th	Jan. 21st	
Dates of trial			
Jackets	Not used	Used	
Duration of trial min.	245	246	
Type of boiler—locomotive			
Heating surface—fire-box sq. ft.	116	116	
,, tubes ,,	764	764	
,, total ,,	880	880	
Number of tubes	106	106	
Dimensions of tubes—11ft. 1¼in. by	2¼in. out side dia meter.		
Material of tubes—steel			
Grate area sq. ft.	23	26	
,, during trial ,,	13	13	
Number of fire-bars	80	80	
Width of bars in inches	⅞	⅝	
,, air spaces ditto	½	½	
Total heating surface to grate - ratio	33·8	33·8	
Area through tubes sq. ft.	2·92	2·92	[23ft. high
Size of chimney diameter	24in.	24in.	Temporary ditto,
Total water used during trial—lbs.	8133	6796·5	From engine condenser 5776·5,
Water per hour ,,	1092	1657·6	
Total coal used ,,	800	672	auxiliary 400,
Coal per hour ,,	195·9	163·9	jackets 620
Coal per square foot of grate area per hour lbs.	15·09	12·6	
Water evaporated per lb. of coal	10·16	10·11	
Water evaporated from and at 212 deg. F. lbs	11·81	11·69	} Taken every 15
Average boiler pressure ,,	153	157·69	} minutes
,, height of water in glass—inches	1·54	·84	
Total number of revolutions	31,263	29,920	
Revolutions per minute	127·6	121·6	
Circumference of brake feet	30·8	30·8	
Weight on brake lbs	1014	946	
Pull on spring balance ,,	70	4·77	
Net load	944	941·23	
Brake horse-power	112·8	106·85	
Water per brake H.P per hour, lbs.	17·67	15·513	Including jackets
Coal ,, ,, ,,	1·73	1·534	
Indicated H.P.—high-pressure	50·27	40·55	Richard's indicator used on
,, medium pressure	50·04	42·6	19th. Crosby's
,, low pressure	44·9	39·38	on 21st.
,, total	145·21	122·33	
Water per indicated H.P. lbs.	13·7	13·54	Including jackets
Coal ,, ,, ,,	1·349	1·339	
Brake ratio	77·67%	87·35%	
Total condensing water gallons	10 060	9695	
Condensing water per hour ,,	2464	2365	
Proportion of ditto to feed-water	12·37—1	14·41—1	
Temperature of hot well—Fah. deg.	108	95·18	} Taken every 15
,, feed tub	102·5	108·75	} min. [trial
,, condensing water	37	36	Taken 3 times d'g
,, discharge	111	98·18	} Taken every 15
,, smoke-box	474·7	456·5	} minutes
,, boiler-house	63	68	Taken 3 times
,, engine-house	51	56·5	,, ,,
Vacuum in condenser inches	27·5	27·98	} Taken every 15
,, smoke-box ,,	·13	·105	} minutes
Barometer	29·81	29·08	Taken twice.
Coal used—Ebbw Vale			

The low-tension mains were manufactured and laid by Callender's Bitumen Telegraph Company, under the superintendence of their engineer, Mr. W. Douglas Reid. These cables are of two sizes, ½ square inch and ¼ square inch

section, and are of the lead-sheathed type, armoured with two layers of steel tape. These cables are simply laid in a trench under the footway, at a depth of about 18in. They are laid in lengths of from 150 to 200 yards, and are connected together in cast iron joint-boxes by means of copper connectors. The box is then run in solid with bituminised wax compound. Disconnecting branch boxes are provided at different points in the network, so that any section or street can be cut out without in any way interrupting the supply to the rest of the network.

House service wires are connected in T boxes by means of T copper connectors. These boxes and connectors are so made that the cable is not cut, but is simply bared down to the copper strands and the connector put on and soldered. The box is then run in solid with the bituminised wax compound. The small service wires are of two sizes—$\frac{7}{14}$ and $\frac{19}{14}$—lead sheathed and armoured. The arc cables are similar, but $\frac{7}{19}$. The whole installation is a very interesting example of the possibility of using high-tension continuous currents for large areas.

AMERICAN ENGINEERING NEWS

County roads.—The supervisors of Richmond County, Staten Island, New York, are having the main roads rebuilt and improved, and about sixty-seven miles of roads have already been arranged for, and contracts let for thirty miles. The legislative act under which the work is to be done is unusually wise in that it provides that the roads must be constructed and repaired and continuously maintained under full control of a competent engineer. Of the thirty miles which will be completed this summer there are 6⅛ miles of Telford, 16⅝ miles of macadam, and seven miles of repair and reconstruction. The width of roads varies from 14ft. to 30ft., and the depth of construction from 6in. to 12in. The average cost is estimated at 8500 dols. per mile. There are from 300 to 600 men employed, and seven steam rollers are used, one of twenty tons, one of fifteen tons, and five of ten tons weight. The stone is mainly trap from quarries on the Hudson River and in New Jersey. The Telford paving consists of a pitched foundation of 8in. granite or trap blocks, with the interstices filled with spawls, and the foundation then rolled. Two layers of 2in. broken stone are layed and rolled separately, covered with a top dressing of trap rock screening, watered and rolled, making a smooth and clean surface. The macadamising consists of 4in. of 3in. broken stone, covered with 4in. of 2in. broken stone, top dressed and rolled as above. In repair work the old surface is picked to a depth of 2in., the loose stone well raked, new broken stone added and rolled, and the top dressed with screenings and rolled.

Fast train record.—The Empire State express of the New York Central and Hudson River Railway, which has a run of 440 miles from New York to Buffalo, N.Y., in 5 hours 40 min., with four stops, is the fastest regular train in the world, having an average speed of 50⅔ miles an hour including stops, and 53 miles an hour exclusive of stops. This means that the train makes a considerable part of its run at speeds of over 60 miles an hour. This is a very popular train, keeps its schedule time well, and is the best paying train on the road. On a recent run of this train, tests were made and indicator diagrams taken on the first stretch of 143 miles, from New York to Albany, on which division there is practically a continuous level grade. The highest speed when a diagram was taken was 80 miles an hour, with an indicated horse-power of 1120. At 60 miles an hour it was 960-horse power; at 70 miles, 1059-horse power. At 60 miles an hour the cylinder pressure is 40·7 lb. The fuel was small bituminous coal, carefully fired. The engine was of the eight-wheel type, with four driving wheels, 6ft. 6in. diameter, a four-wheeled leading truck and cylinders, 19in. by 24in. The train weighed 170 tons, consisting only of four cars; the engine weighed 60 tons, and tender 40 tons, giving a total train-load of 270 tons. The train was small and light, having only four cars, and not being encumbered with heavy sleeping or dining cars. The average coal consumption was 3½ lb. per horse-power per hour, and the average train resistance 19 lb. per ton. Engines with 7ft. driving wheels are to be tried on this train.

Water supply.—The annual meeting of the New England Water-works Association was held at Holyoke, Mass., June 8th, 9th, and 10th. Mr. George A. Ellis read a paper favouring direct pressure for fire protection, and explaining two methods of turning on the direct pressure from the pumps with combined pumping or stand pipe systems of waterworks. In a paper on "Hydrants and Water Pipes for Fire Protection of Cities," Mr. John R. Freeman stated that 250 gallons per minute are required for a good fire stream. At present 2½in. hose and 1½in. nozzles are the standard, but he advocated 2½in. hose and 1¼in. nozzles, with a nozzle pressure of 40 lb. to 50 lb. Hydrants should not be more than 500ft. apart, or 300ft. near important buildings. Fire mains should not be less than 6in. diameter. The number of fire streams which should be available for simultaneous use he gave as follows:—

Population of	1,000	2 to 3	fire streams
,,	5,000	4 ,, 8	,,
,,	10,000	6 ,, 12	,,
,,	20,000	8 ,, 15	,,
,,	40,000	12 ,, 18	,,
,,	60,000	15 ,, 22	,,
,,	100,000	20 ,, 30	,,
,,	200,000	30 ,, 50	,,

Professor Droun stated that aëration of water does not purify it by oxidation, but does remove odours from the water, and, by agitation, prevents the formation of algæ. Another important paper was upon the purification of water by sand filtration.

Railways.—The Adirondack and St. Lawrence Railway, which is a line in the Vanderbilt interest, running from Utica, N.Y., on the New York Central Railway and West Shore Railway, along the west side of the Adirondacks north to Valleyfield, on the St. Lawrence River, a distance of about 150 miles to 200 miles, will be opened this summer, and will form a new and competitive route to the Adirondack region and Montreal from New York and the east. The Great Northern Railway is making new surveys for a line from Portland, Ore., to Seattle, Wash., about 185 miles. This line was surveyed in 1890 and work commenced, but soon abandoned. As laid out it had grades of 70ft. and 80ft. per mile, or 1·33 per cent. to 1·5 per cent., and the new survey is being made with a view of keeping the grades down to a more favourable limit. The Canadian Pacific Railway is building extensions to its lines in the southern part of Manitoba, and will build a line to the Deloraine and Assiniboin coalfields, but no extensive work will be done this year in the north-west. New lines to aid in the development of British Columbia are projected. The West Virginia and Pittsburg Railway is building an important and difficult line to connect the coalfields of West Virginia with the Chesapeake and Ohio Railway. The Baltimore and Ohio Railway will soon make arrangements for the use of its new terminal on Staten Island, in New York Bay, with steam ferry boats to New York and Brooklyn. The connecting line and great drawbridge were built some years ago, but have only been used for a small freight traffic.

A long electric railway.—Surveys have been made for an electric railway between Chicago and St. Louis, a distance of 250 miles, on which it is proposed to run trains at 100 miles per hour. The maximum grades are 2 per cent., two being ordinary grades and the others short approaches to bridges. The country is practically level. There will be two tracks of standard gauge, with poles between having cross-arms carrying the trolley wires, which will be over the side of the car, the trolley being attached to a bracket on the side of the car. A compound rail weighing 75 lb. per yard, and resembling the Barker-street car rail and chair, will be used, with wooden cross-ties and stone ballast. There will be two tracks for through trains, and eventually two other tracks for slow trains. The location is a perfectly straight line, except for curves in the two cities, and three or four short level lines will be built to important towns. The line is expected to cost 6,000,000 dols., and to be completed in time for the World's Fair, when the fare will be 5 dols. for the round trip. There will be two power stations, one at a water-power site and the other at a coal mine. The generators will be similar to those of the Frankfort plant, and the line will be divided into twenty-five sections of ten miles each. The cars will be carried on two trucks or "bogies," each with one pair of 31in. wheels and one pair of 6ft. driving-wheels, with a motor mounted on the axle. Negotiations for construction are now being made, and one of the cars is being built.

Twenty-four hour notation.—The system of reckoning time by twenty-four hours, instead of by two divisions of twelve hours each, has been under discussion for some years by different scientific and railway societies, and the American Society of Civil Engineers at its annual meeting recommended the adoption of this system by railways throughout the country. The representatives of several thousand miles of the leading railways have signified their approval of the system, and are ready to adopt it when a general move is made in this direction. The system is in use on the Canadian Pacific Railway. On the whole it has been given a thorough test for five years, is in operation upon 20,000 miles of railway in America and Europe, and is favoured by men representing 140,000 miles of road. It is proposed to endeavour to get it generally adopted by the United States railways on October 12th, 1892.

Long distance telephones.—The American Telephone and Telegraph Company is erecting its metallic circuit wires between New York and Chicago, about 975 miles. Owing to the increased cost of construction over that of a telegraph line, only such cities will be touched as promise a paying business. The long distance telephone lines extend from New York south to Washington, 250 miles; and east to Boston, 260 miles; but successful tests have been made of a talking circuit 1500 miles long. Telephone experts are now engaged in experimenting with telephone repeaters which will enable the company to relay messages.

Launch.—The American steamship El Norte, of the Morgan Line, an iron boat of 4500 tons register, was launched from the ship-building yard at Newport News, Va., on June 14th. She is the twelfth addition to the coastwise fleet of the Morgan Line, and will run between New York and New Orleans with three sister ships. She is a sister ship of the El Sol, which was launched at Baltimore, Md., a year ago, the El Sud, which was launched in March, at Newport News, and of the El Rio, now being built at the same yards at Newport News. The El Norte is 406ft. long over all, 398ft. between stem and propeller post, 48ft. moulded beam, 34ft. from keel to upper deck, 33ft. length of hurricane deck, 4552 gross tonnage, 3021 net tonnage, 14,000 cotton bales capacity of hold; speed, sixteen to seventeen knots. The vessel has three decks, with a partial orlop deck at fore end of fore hold. The lower and main decks are divided into sections by ten transverse bulkheads. These are designed to be watertight and to offer a safeguard against sinking in case of collision. The hull and deck houses are of iron. One of the novelties in construction is in the skin plating. The plates below the water-line have lap-joints—the forward plate lapping over the end of the after plate so as to reduce the resistance to the water—instead of the usual butt-joints with inside strap plates.

The vessel will be rigged with four iron pole masts, carrying fore and aft sails, which will be an appreciable factor in speed when the wind is fair. They will also enable the vessel to keep the seas in safety in the event of her machinery becoming disabled. The masts are fitted with cargo booms for handling freight, together with six donkey or steam hoisting engines situated at the different hatches. The freight hatches and ports are so situated as to facilitate the loading and unloading of freight. There are four coal ports on each side of the ship. A steam windlass and steam capstan are provided for the handling of anchors and hawsers, and on the after deck will be fitted a drum and steel hawser for towing purposes. She will be fitted with a steam steering gear, and can be steered from the forward pilot-house by the steam steering apparatus or by hand gear from the after house. Five of the ports are made to be adapted for 6in. rifles, so that the vessel can be used as a cruiser in time of war.

The officers' quarters are spacious and well ventilated. They are situated in the iron deck-houses on the spar deck. The state-rooms are lighted by ground glass side-lights. The crew will find accommodations of an excellent character, and their quarters are fitted with many conveniences that are unknown on the ordinary type of freight steamer. This is a matter in which Mr. Hutchinson, the president of the Morgan Line, takes an especial interest.

The engines are of the direct-acting, inverted, surface-condensing, triple-expansion type. The cylinders are 32in., 52in., and 84in. in diameter, by 54in. stroke. The valves are all of the piston type on the front of the engine and close to the cylinders. There is one valve only on the high-pressure and intermediate cylinders and two upon the low-pressure. They are driven by the See-Marshall valve gear.

The crank shaft is in two lengths, with pins and main bearings 16in. diameter. Steam will be supplied by three double-ended cylindrical boilers, having three corrugated furnaces at each end. They all lead into a common combustion chamber. The working pressure is 170 lb. per square inch. The boilers are fired fore and aft from two fire-rooms. A notable improvement in the construction of the fire-room was introduced by Mr. Horace See, the naval architect and marine engineer. Where the lower tier of furnaces is placed there is usually in American ships a square depression in the floor, into which coal, ashes, or water falling accidentally are very hard to get out. The fire-room floor of the El Norte is so constructed that, while the furnaces are readily accessible, there is no abrupt depression in the floor level.

The space over the fire-rooms is unobstructed, and the bulkheads at the extremities run clear to the top of the deck-house. The result of this style of construction, as was found in El Sol, a vessel of a similar type built about a year ago, is that the fire-rooms are thoroughly ventilated. The hot air rises through the centre of the clearway, and is displaced by the cooler atmosphere which pours down the sides. This is an improvement that will be greatly appreciated by engineers and stokers, who know what it is to be in a hot and badly-ventilated fire-room. The firemen usually manage to stand the heat of the furnaces so long as there is a free circulation of air, but often succumb when the ventilation is bad. The engines and boilers were designed by Mr. Horace See, the superintending engineer for the Morgan Line steamships. The ship, boilers, and engines have been built by the Newport News Ship-building and Dry Dock Company.

LAUNCHES AND TRIAL TRIPS.

On Saturday afternoon, the 25th inst., Messrs. Craig, Taylor and Co., launched from their Thornaby shipbuilding yard, Stockton-on-Tees, a handsomely modelled steel screw steamer of the following dimensions:—312ft. by 40ft. by 22ft. depth moulded. The vessel has been built with a partial awning deck, and raised fore deck forward. She is on the web frame principle, and has double bottom for water ballast all fore and aft, and in peaks for about 680 tons. She will be fitted with four steam winches and steam steering gear, direct steam windlass, screw gear aft, and all modern improvements so as to admit of rapid loading and discharging. The engines, on the triple-expansion three crank system, are being constructed by the North-Eastern Marine Engineering Company, Sunderland, and are of the following sizes:—22in., 35in., 57in., by 30in. stroke; two steel boilers 160 lb. pressure. The vessel has been built to the order of Messrs. Neill, Topping and Co., Great St. Helens, London, and under the superintendence of Captain John S. Naile. As she left the ways she was named the Ardrishaig by Miss Janet E. Naile, daughter of Captain Naile, who will take command of the vessel.

On Saturday, the 25th inst., there was launched from the yard of the Tyne Iron Shipbuilding Company, of Willington Quay-on-Tyne, a steel screw steamer built to the order of Messrs. Graham, Anderson, and Co., of Carlisle, and of the following dimensions, viz.:—Length, 315ft.; breadth, 40ft. 6in.; depth 23ft. 7in. moulded, and to class 100 A 1 at Lloyd's on the partial awning decked rule. This vessel has water ballast fitted right fore and aft on the cellular system, and is also fitted with all modern improvements for the rapid loading and discharging of cargo, including four double cylindered steam winches, direct-acting steam windlass, large donkey boiler, steam steering gear and screw gear aft. The engines, which are to be supplied by Messrs. The Wallsend Slipway and Engineering Company, are of the triple-expansion type, having cylinders 23in., 38in., and 61in., by 45in. stroke, and working at a pressure of 160 lb. On leaving the ways the vessel was named the Leander by Miss Anderson of Weatherall.

On Thursday, June 23rd, Messrs. Furness, Withy, and Co. launched from their yard at Hartlepool a large screw steamer, built to the order of Messrs. Burdick and Cook, London. She is a fine type of a modern cargo boat, measuring over 280ft. in length, and built throughout of iron, with a large measurement and dead-weight capacity, and built to the highest class at Lloyd's. The vessel has a long raised quarter-deck, short poop, long bridge-house, and a topgallant forecastle. The holds are fitted with iron grain divisions, and all decks, deck erections, skylights, bulwarks, bulkheads, &c., are constructed of iron. Cellular bottom fitted all fore and aft for water ballast. The greater portion of the plates are in 24ft. lengths, making the structure of the ship very strong. Four steam winches, one donkey boiler, patent steam steering gear amidships, screw gear aft, direct steam patent windlass, stockless anchors, hauling into hawse pipes, and other modern appliances are fitted for the handy working of the vessel. The saloon and cabin, providing accommodation for the captain, &c., is handsomely finished in polished hardwood, with upwards of thirty-six hand-painted panels, executed in an effective style by the staff of ladies employed by the firm. The steamer will be rigged as a two-masted fore-and-aft schooner, and has been constructed under the personal supervision of Mr. J. Cook. She will be fitted with triple-expansion engines by Messrs. Blair and Co., Stockton-on-Tees. On leaving the ways she was named Marie by Madame Arthur Letellier.

On Monday, Sir Raylton Dixon and Co. launched from their No. 2 dockyard two iron steam trawlers, which have been specially built for the North Sea fishing trade. Every modern improvement has been embodied in their construction and outfit. The principal dimensions are:—Length between perpendiculars, 101ft.; beam, 20ft. 5in.; depth moulded, 11ft. 8in.; and they will be fitted with engines 11½in., 18in., and 29in. by 21in. stroke, with good boiler power.

On Tuesday a further addition was made to the fleet of the White Star Line by the launch of the large cargo steamer Bovic at the shipbuilding yard of Messrs. Harland and Wolff, Belfast. The Bovic—says the *Times*—is in every respect a sister ship to the Naronic, which was launched last month at the same yard. She will have two sets of triple-expansion engines driving twin screws, and a length of 470ft., breadth 53ft., depth of hold 35·6ft., and a gross registered tonnage of about 6000 will make her and the Naronic the largest freight steamers afloat. These are the first two steamers that have been built in accordance with the recommendations of the committee appointed by the President of the Board of Trade in 1890 to consider and report upon the spacing and construction of water-tight bulkheads in merchant steamers. The Bovic will be fitted to carry about 1050 cattle on her upper main decks, and she will also have very special accommodation for horses amidships. On leaving her builders' hands the Bovic will, with the Naronic, which is now rapidly approaching completion, take her place in the freight service of the White Star Line between Liverpool and New York. These two steamers, combined with the Nomadic, Tauric, Cufic, and Runic, will then begin a regular weekly sailing from Liverpool every Friday and from New York every Tuesday.

Messrs. Fleming and Ferguson, shipbuilders and engineers, Paisley, launched on Monday the self-propelling and twin-screw dredger Cairndhu, built to the order of the Clyde trustees, to be used in the further deepening and improvement of the river Clyde. Her dimensions are 200ft. long, by 34ft. broad, by 15ft. 6in. depth. Her chain of buckets consists of 47, each bucket having a cubic capacity of 22ft. She is to dredge to a depth of 40ft. below water, and will be capable of raising 1000 tons an hour of ordinary material. She is fitted by the builders with their patent independent traversing gear for travelling the bucket ladder in advance of the hull, and so enabling the dredger to cut her own flotation. The main engines are compound surface-condensing, and capable of indicating 800-horse power, steam being supplied by two large horizontal multitubular boilers. To permit of machine being easily and quickly handled, there are six sets of auxiliary engines, all independent of main engines, so that manipulation of machine is well under control. The steel for gearing and buckets is of the highest quality. The gearing is fitted for two speeds, so as to suit the kind of material the machine may be dredging.

H.M.S. ST. GEORGE.—The ship is of the same class as H.M.S. Endymion, launched last year from Messrs. Earle's yard. She is a first-class protected cruiser, but being sheathed she is of greater displacement—7700 tons against 7350 tons—and has slightly more beam. The dimensions of the St. George are:—Length between perpendiculars, 360ft.; breadth, extreme, 60ft. 8in.; draught of water, 24ft. 9in. She will be propelled by twin-screw engines of 12,000 indicated horse-power, supplied by four very large double-ended main boilers and one auxiliary ditto, and is expected to attain a speed of 20 knots. In the machinery space the cylinders are protected by glacis armour, 6in. thick—compound—fitted between the protective and main decks over the extent of the engine-room. A protective deck, 2½in. thick, extends over the greater portion of the length, tapering to 2in. at ends, and on the slope of the deck the maximum thickness is 5in. The conning tower is of 12in. compound armour, with armoured communication tubes 7in. thick. Between the protective and main decks ready-use magazines of 3in. steel are fitted for supplying the casemate guns and 6in. guns on the upper deck. The double bottom in the machinery space is divided into twenty-seven water-tight compartments, but the double bottom is virtually extended nearly throughout the length of the ship by means of the flats to magazines, &c. Her armament consists of: Two 9·2in. breech-loading guns on centre pivot mountings, fitted on upper deck and protected by shields; six 6in. quick-firing guns on centre pivot mountings, fitted on upper deck and protected by shields 3in. thick; four 6in. quick-firing guns on centre pivot mountings, fitted in casemates on main deck, and protected by 6in. compound armour in the front, and 2in. steel plating at rear; twelve 6-pounder quick-firing guns, distributed as follows:—Two on forward-deck shelter; two on after-deck shelter; four on upper-deck; two on main deck, forward; two on main deck, aft.; five 3-pounder quick-firing guns; seven 0·45 5-barrel Nordenfelts. Torpedo tubes, above water broadside, two in number; below water broadside, two in number; eighteen 18in. Whitehead torpedoes. The order for the St. George was placed with Earle's Company, in December, 1889, and had it not been for strikes of workmen and other unforeseen impediments, she would have been launched some little time since, but the fact that she has remained on the stocks does not signify that the work is only just sufficiently advanced for floating her; as a matter of fact, the internal work is much further advanced than was the Endymion's at launching, and her machinery is finished and erected in the shop ready for going into place. She will, after floating, be towed into the Alexandra Dock, and berthed under the big crane there for the purpose o placing the engines and boilers on board. This ship was launche on the 23rd June, by Lady George Hamilton, in the presence of large and distinguished gathering.

LOCOMOTIVE ENGINES IN NEW SOUTH WALES.

MANY of our readers are no doubt aware that the management or mismanagement of railways in New South Wales has for years been a burning question. Finally, an Act was passed by the Colonial Parliament appointing Commissioners to manage the railways. One of the first acts of the Commissioners was to purchase a number of engines from the Baldwin Locomotive Works. But before this was done an energetic attempt was made to get the engines needed built in the Colony. This attempt failed. A determined and acrimonious attack has been made on the Commissioners by various Sydney newspapers, and the breakage of axles in the American engines, and delays due to hot boxes, lent weight to the attack. At last things came to such a pass that a Royal Commission was appointed to inquire into all the circumstances connected with the ordering of the Baldwin engines, very grave charges having been brought against certain of the Railway Commissioners. These charges possess no scientific interest, however, and we shall not further refer to them. Our concern is, of course, only with the engines, and with them alone. *The Sydney Morning Herald* of May 19th has just reached us, and in it we have the full text of Mr. Eddy, the chief Railway Commissioner's statement, put in on oath on the 18th of May. This document is very long, but it contains a great deal of interesting information, and we reproduce it in a slightly condensed form; we have only eliminated matter which possesses no interest outside the Colony. After a few preliminary remarks, Mr. Eddy said:—

The New South Wales railways are most exceptional in their character, having been constructed with an enormous proportion of steep gradients, the worst grades being on the trunk lines, and so situated that the whole volume of traffic has to pass over them. The only way—now that the traffic is increasing so rapidly—to stave off a great amount of duplication work, is to introduce more powerful engines, and so, by taking much longer trains at a better uniform speed, to enable the bulk of the singles lines to carry satisfactorily, for some time to come, the traffic, which could not otherwise be carried with the old class of motive power and system of short trains without grave delays and inconveniences. When the duplication works in hand are completed we shall only have 150 miles of double line in existence, of which 8½ miles are quadrupled; whereas in the sister colony of Victoria, with its far easier grades, 297 miles of double line exist. The difficulties surrounding the working of the New South Wales railways, having more than 2000 miles of single line and exceptionally sharp curves—the steepest grades being also on the main lines within a short distance of Sydney—will be readily understood when I state that there are 629 miles of grades, varying from 1 in 30 to 1 in 75, in the following proportions:—

Gradient.	As originally construct'd.	Total.	As improv'd by dev'tion since 1888.	Total.
	m. ch.	m. ch.	m. ch.	m. ch.
1 in 30 to 1 in 33	25 20	—	24 54	—
1 in 34 to 1 in 40	165 25	190 45	165 25	189 79
1 in 41 to 1 in 50	188 60	374 25	183 9	373 8
1 in 51 to 1 in 60	112 12	486 37	109 6	482 14
1 in 61 to 1 in 75	144 59	631 16	146 60	628 74
Totals	631 16		628 74	

The Western line, for instance, is a more difficult line to work than any of the Alpine railways, the ruling grade, radius of curves, and frequent loss of elevation, which has to be regained, being all against the railways of this Colony. The table which I place before you illustrates clearly the relative positions of the various lines in question.

Railway.	Portion of line shown on diagram. Length of incline.	Rise.	Maximum grade ascending.	Sharpest curve.	Portion of line not shown on diagram. Remarks.	Maximum grade ascending.
	Miles.	Feet.		Chains.		
Brenner	22·25	2586	1—40	14·16	Rises *nil*	—
Mont Cenis, North	24·75	2637	1—33·3	17·0	Do. do.	—
Mont Cenis, South	25·25	2793	1—33·3	24·0	Do. 13ft. in 3½ miles	1—1000
St. Gothard	18·5	2100	1—38·5	14 to 15	Do. 126ft. in 4½ miles	1—172
N.S.W. (West)	20·5	3248	1—30	8	Do. 323ft. in 22 miles	1—33
N.S.W. (South)	15·5	1477	1—30	16	Do. 322ft. in 23 miles	1—30
N.S.W. (North)	30·0	2105	1—40	12	Do. 890ft. in 71 miles	1—44
					Falls to zero from foot of incline in 17 miles..	1—50

As many as 196 wagons of live stock in addition to the ordinary goods and passenger traffic have been moved in one day from the Western line to Sydney—Homebush. This additional traffic had to be worked until these Baldwin engines were brought here in short trains of 15 wagons over a length of nearly 500 miles of single lines, with grades ruling the load of 1 in 40, 1 in 30 and 33, for nearly 250 miles of the journey; is a great disturbing and difficult element to deal with, and any improved method for working the traffic in fewer trains is much to be desired. The live stock traffic is also growing very largely. As pointed out when the Commissioners took office, there was such an indefinite variety of types of locomotives that they decided, in the interest of economy and facility of repair, to adopt as few classes as possible; and, with this in view, determined that the new passenger engines should be sufficiently powerful to work a paying load of live stock or goods, and the engines placed upon the lines—Baldwin and English—effect this object. The failure of the various negotiations for the supply of engines to be built in the Colony, and consequent great loss of time, the rapid increase of traffic, the worn-out condition of many of the locomotives, and the prospect of an exceptionally heavy wool season, rendered the immediate addition of a new stock absolutely necessary. English locomotive builders being very busily engaged, and consequently unable to supply our wants promptly, the Baldwin works were applied to and offered to deliver a large number of most powerful locomotives within an unprecedentedly short period. While English locomotives are distinguished for the careful design of their details, excellent workmanship, and general durability, American engines, while possibly inferior in these respects, undoubtedly possess great hauling power and flexibility, and are consequently adapted for heavy gradients and sharp curves, and for road beds which are not so well constructed as those found in England. The Baldwin Company is the largest firm of locomotive builders in the world, having built over 12,000 engines, and their output in 1890 was 946 engines—about four times as many as any English maker. Their enormous output is a proof that their work gives satisfaction. In fact, in America the Baldwin works enjoy a special reputation for the improved design of their engines, which are to be found running on nearly all the principal railroads of the United States. The Baldwin works also export more locomotives than any other locomotive builders in the States, and their engines are to be found in all parts of the world. It may be interesting to state that the number of engines built by the Baldwin Company is equal to three-fourths of the whole of the locomotives running on the railways of Great Britain. The actual performances of the two classes of Baldwin engines have been satisfactory, and the only defects have been in the axles and small details, which have been put right at the cost of the makers. The passenger and goods engines have already run over 450,000 miles, and the average failures are less than other engines of somewhat similar type. The returns which have been already supplied to the Commission show, I think, that the ordinary running repairs are very moderate when the heavy work the engines are doing is considered. Previously to giving the present order the Government had very satisfactory proof of the class of work turned out by the Baldwin Company, that firm having supplied thirty-three locomotives for the New South Wales railways and ninety-one motors for our tramways. It was therefore no new experiment or departure on our part to obtain supplies from that firm; and as one of the leading partners in the firm had some years ago spent a considerable time in the Colony, they were in an exceptional position to understand our requirements, which were most urgent. Doubtless the average amount of fuel burned per train mile is less on English than on American lines, yet if the computation were per ton of train hauled per mile, it would be found that the consumption is less on American than it is on English lines, without taking into consideration the difference in the grades and curves. In my opinion, there are many features in American locomotives which might with advantage be adopted by English engineers. With our heavy grades and curves and growing traffic on single lines a new departure in locomotive power was absolutely necessary, and the results which are beginning to be accomplished clearly demonstrate the wisdom of the action of the Commissioners, the earnings per train mile for the quarter ending 31st March last showing at the rate of 7s. 5½d., as against 6s. 6d. for the same quarter of 1890—this is upon a total mileage of over two millions of miles in the quarter. That alone will carry conviction to anyone who thinks of railway management. The amount of assisting-engine miles has been largely reduced.

We may stop here to point out that it is by no means so clear to the locomotive interest in this country as it is to Mr. Eddy that the necessary engines could not be, or rather would not be, supplied by English or Scotch builders. A great deal depends on the stipulations as to time of delivery, terms of payment, &c., and it is not likely that the last word has been heard on this point. To resume:—

I think it will be desirable for me to distinctly describe the weight, &c., of the Baldwin engine and tender.* The total weight of the engine when empty is about 51 tons 5 cwt. 1 qr.; when loaded to its fullest extent with water in the boilers, &c., it weighs about 58 tons 7 cwt. This weight is distributed over ten wheels, four belonging to the bogie in front of the engine, and the other six are coupled driving-wheels, the middle pair being without flange, so as to reduce the strain on the permanent way in going round curves. The average weight on the three driving axles is 14½ tons, but a weight of about 15 tons 6 cwt. is placed on the middle or flangeless pair of wheels; therefore a weight of about 7 tons 13 cwt. is the greatest weight on any one wheel in the engine when it is fully loaded. The tender, which is mounted on two sets of four-wheeled bogies, weighs when empty 13 tons 12 cwt., and when loaded with its maximum quantity of coal and water about 32 tons. It will therefore be seen that the engine as arranged is exceedingly flexible, and far less destructive to the permanent way, with so many curves of 8, 10, and 12 chains radius as we have on our main lines, than engines which have been running here for years past. These engines are now daily working trains which formerly required two engines to draw them, and are also doing the work in a much more satisfactory manner. Two engines were employed in working the Western mail from Penrith to Wallerawang or Bathurst four out of every six nights in the week, and on the remaining nights as far as Katoomba. An assistant engine had also to be kept in readiness at Bathurst to assist the train if necessary as far as Dubbo, the throughout distance Penrith to Dubbo being 244 miles. The day train Sydney to Orange also had to be assisted three days out of four between Penrith and Katoomba. By the introduction of the Baldwin engines, one engine—excluding a few very exceptional cases—has a reserve of power for dealing with the ordinary traffic without entailing the necessity for attaching an additional engine. The 5.50 p.m. train, by which regular passengers return from Sydney to the mountains, has been accelerated since the Baldwin engines have been put to work it by 15 minutes between Penrith and Wentworth Falls, and is now running punctually; whereas formerly, even when assisted by a second engine and with 15 minutes additional time, it was almost always late. The Saturday afternoon special train, Sydney to the Mountains, has also been accelerated in a similar manner, and is now worked by one engine with the same result as regards time-keeping and assistance. It should be self-evident that the one engine weighing, with its tender when fully loaded, about 90 tons, will do less harm to the permanent way than two coupled together, weighing in the aggregate 128 tons.

Mr. Eddy then goes on to argue that the Baldwin engines, having more brake-power than those which they superseded, were safer, and he cites a recent accident to enforce his contention. But the whole argument is very weak, because, obviously, it is just as easy to provide sufficient brake-power with one type of engine as another, and two engines and tenders ought to be as well provided in this respect as one, while the whole braked weight might be greater with two than with one. We omit the report on the accident in question, and go on with Mr. Eddy's own words.

On the Southern line, in working the Melbourne express, the same system of working with two engines was in operation, the two engines with their tenders weighing 128 tons, whereas a single English ten-wheeled engine weighing about 88 tons works the train with ease. The weight of the Southern express and mail without engine and tender varies from 130 to 192 tons, and may be taken at an average of 156 tons. Weight to pass over line: Train, 156 tons; two engines, 128 tons; total, 284 tons. Train, 156 tons; ten-wheeled engine, 88 tons; total, 244 tons—a saving in weight to be hauled of 40 tons, and also relieving the permanent way of the same amount of wear and tear. In working the Southern express and mail trains between Sydney and Junee, nine of the new engines will displace seventeen of the lighter machines. Capital outlay:—seventeen old four-wheeled engines, coupled, at £2870, £48,790; nine engines at £3700, £33,300: reduced capital, £15,490. Mileage per annum of the two services, with assisting mileage:—Under old system, 563,760 miles per annum; under new system, 345,000 miles per annum; saving per annum, 219,000 miles. The average cost of each engine mile for the whole line amounts to 12·35d.; therefore if the saving of running one of the engines is placed at the low estimate of three-fourths of the average cost, viz., a saving of 9d. per mile in connection with the mileage saved, there will be an annual saving of £8212 per annum, or £912 per annum each engine. The capital outlay for the nine engines at 4 per cent. is £1332 per annum, or £148 per engine. The investment in each new engine, after paying interest on the same, means a net saving of at least £764 per annum, and all the advantages described are also gained. With regard to the American goods engines, from very carefully prepared return made by the out-door superintendent and the chief traffic manager, it would appear that during the months of February and March fifteen of these engines on the Western line saved 27,000 train miles, as against working the traffic in absolute full train loads by the most powerful of our ordinary goods engines. These are two light months of the year, and it is estimated that on the whole year's working a saving of about 222,000 miles will be effected. Another great advantage gained is the reduction in risk of accident, by having fewer trains on the lines, and the fewer delays that will be experienced in passing the traffic along the single lines. To illustrate this, it may be mentioned that in February, between Penrith and Dubbo, 15,219 wagons were moved by 551 trains, worked by the American engines, whereas it would have required 796 trains worked by the ordinary engines to have moved this number of wagons. It may also be pointed out that, looking at the great power developed by these engines, the price paid for them is an exceedingly moderate one. Indeed, it has not been suggested in the course of this inquiry that the expenditure incurred in their purchase has been in any way excessive or extravagant.

So far, it will be seen that Mr. Eddy's arguments are simply in favour of working a very heavy road with big engines. Beyond question this is sound policy, and the results ought to be satisfactory, but it has nothing to do with the preference given to American over English engines. Indeed, as will be obvious, the few heavy English locomotives which, it seems, the Colony owns are doing their work in a perfectly satisfactory way. Mr. Eddy now comes to the charges brought against the American engines; but his statement of them in no way does adequate justice to the acrimony with which they have been put forward by a section of the Sydney press. For example, no allusion is made to the assertion that the wheels of several of the engines had broken spokes. Of course, it must be understood that we do not endorse or support these charges in any way. It is proper to state, however, that several weeks ago we received from Sydney a detailed and categorical statement of these charges. Before making any use of this, we believed that it would be fair to hear what Messrs. Burnham, Williams, and Co., the proprietors of the Baldwin Locomotive Works, had to say on the subject, and we wrote to them and forwarded a copy of the charges. To this letter we have received no reply. Mr. Eddy says:—

I will now deal with the charges seriatim. The first charge is, "That, in consequence of the extra width of the Baldwin engines, or their great length, the platforms on various parts of our lines have had to be altered." This is certainly inaccurate. The facts of the case are that either various platforms, &c., had been erected since the lines were opened without proper attention having been paid to building them to the gauge laid down by the late engineer-in-chief—Mr. Whitton—or, in maintaining the roads the rails had been moved towards the structures. The grave inconvenience and danger arising from this state of things was brought forward prominently years before the commissioners took office, but the subject was not effectually dealt with until the present board took over the control. The question, however, was dealt with and decided upon before the Baldwin engines were ordered. Had the works been kept to the gauge laid down by Mr. Whitton, not one penny would have been required to be spent to admit of the running of the engines. The diagram placed before the commission of the standard gauge for works and maximum size of rolling stock in existence before the Baldwin engines were imported shows this clearly. The engines as ordered were within the extreme measurements of engines, &c., already upon the lines, but which had been restricted by the late administration to certain parts of the lines, because of the known defects in gauge. The total cost of making the necessary alterations to admit of the locomotives and rolling stock of the maximum size passing all over the main lines has only amounted to about £3200, a very small sum when looking at the great advantages gained by its expenditure, and whether the Baldwin engines were imported or not, the correction of the gauge was a matter of urgent necessity. With regard to the charge:—"That the safety of the draw gear will be in danger if the Baldwin passenger engines or the Baldwin consolidation goods engines draw the loads that it is stated by the railway authorities they are intended to draw," it has already been shown in evidence that the draw gear in the engines was lighter than ordered in consequence of an error in the Baldwin works, and the draw gear was at once changed at the expense of the Baldwin firm. It has also been shown that the draw gear on the rolling stock is sufficiently strong for all purposes of safety, and that its strength was specially considered prior to the ordering of the engines in question. The recent unfortunate accident at Tarana also established the strength of the draw gear, as it did not break, although subjected to the strain of vehicles being off the line. With regard to the charge "that there are engines already in use on our railway system that are as powerful as the Baldwin passenger engines, and, therefore, another type of engine has been added to our stock, thus increasing the already too many types of engines in existence," there was not in use on our railways a passenger engine as powerful as the Baldwin, and no one in the service could confirm the assertion made. With regard to the types of engines, twenty-eight actually distinct types of engines have been already reduced to eighteen, even if all the new American and English engines are included; and out of the total stock existing at present, of 481 engines standing on the books on capital account, 331 of them belong to four types. When this inquiry was commenced we thought it desirable to see what the engines could do, so we gave directions for both the passenger and goods engines to be tested, and they were tested out on the Western line. They hauled exceedingly heavy loads. The passenger engine was put to draw goods wagons, which is a heavier test than drawing passenger carriages. On the 1 in 33 grade the engine hauled 168 tons at the rate of 14½ miles an hour. On the 1 in 40 grade, a portion of which is 1 in 37, the passenger engine went up this bank at 12½ miles an hour with 195 tons. On the 1 in 50 grade the engine hauled 254 tons at 14·3 miles per hour. The consolidation goods engine up the 1 in 33 grade took 274 tons at 7½ miles an hour, and on the 1 in 40, part of which is 1 in 37, the engine hauled 341 tons at 4·7 miles per hour. On 1 in 50

* An illustration of one of these engines will be found in our impression for 25th March, 1892. The cylinders are 21in. diameter, 24in. stroke; driving wheels 5ft. diameter.

grade the engine hauled 433 tons at 9·7 miles per hour. These are very excellent results. I will read the report of the engineers: — "To the Commissioners of Railways, New South Wales. Gentlemen,—In compliance with your request we have made a careful series of experiments with a 10-wheeled American engine, No. 447, in order to ascertain accurately the performance of the engine when hauling passenger vehicles up grades of 1-30 and 1-40. In your letter to the Baldwin Works, 22nd September, 1890, you stated that you wished the engines to haul regularly a load of 120 tons, exclusive of engine and tender, up a gradient of 1-30, without sharp curvature, and that occasionally you expected that a load of 144 tons should be taken up. On a gradient of 1-40 you stated that the regular load of 152 tons should be taken at about 22 miles an hour, and that the engines should be capable of occasionally taking a load of 176 tons. Our tests were especially directed to ascertain if the engines were capable of performing the above work. The trains were made up of Pullman sleeping-cars and first-class lavatory carriages, and in all cases weighed somewhat more than the stipulated loads. We succeeded in taking no less than 44 indicator diagrams, which will enable us in a few days to present you with a complete report as to the indicated horse-power of the engine, with the tractive-power and the resistance of the train. Meanwhile the data so far obtained enable us to say that the load hauled and speeds obtained were as follows:—

No. of trip.	Gradient	Mean speed on the whole length of gradient. Miles per hour.	Weight of train exclusive of engine and tender.		Remarks.
			Tons	cwt.	
1	1—40	18·50	179	5	Length of gradient, 2½ miles. Several curves of 16 chains radius on first mile.
2	1—40	20·15	157	12	
5	1—40	21·09	157	12	
3	1—30	18·87	121	14	About 2 miles of 1-30 and ¾ miles of 1-33. Curvature moderate.
4	1—30	16·71	144	2	

"We regard the results as extremely satisfactory, and have little doubt that had the driver run such a train regularly, he would have been able to obtain even better results from the engine on the 1-40 gradients, which occurring immediately after he left Picton with a somewhat dead fire prevented the engine steaming as freely as she did on the 1-30 grades. The latter, however, were approached by several miles of easy rising gradients, in running over which the action of the blast thoroughly ignited the fire, and consequently enabled the engine to steam freely and maintain its speed on the grade. We have the honour to be, yours faithfully, (Signed) HECTOR KIDD, ROB POLLOCK." With regard to the charge, "That the Baldwin passenger engines, and the Baldwin consolidation engines are faulty in design, and that certain parts —the axles of the bogies and tenders—were dangerous, and grave neglect was shown by allowing the engines to run before the parts in question were removed," I submit that not one iota of evidence of any weight has been produced to prove that the engines are faulty in design; on the contrary, the witnesses called to testify against the engines have nearly all admitted that they are well designed and are performing the work expected of them. When the charges were promulgated in Parliament, not a defect had shown itself in any of the engines; in fact, only a portion of the passenger engines were in steam, and not one of the goods engines had arrived in the Colony, the first one being put in steam on September 30th, whereas the charges were made on August 20th. Although the attack was made in Parliament on August 20th, the first failure that occurred was on October 27th—more than two months afterwards. With new engines, such small matters like axle-boxes running hot and points of that kind cannot be looked upon as failures, as all new machinery, whether in steamships, workshops, or locomotive engines, requires careful attention for a time. With regard to the failure of bogie axles, &c., the commission has had placed before it a letter from the Baldwin firm, which reads as follows:—"Baldwin Locomotive Works, Burnham, Williams, and Co., Philadelphia, February 15th, 1892. Mr. H. M'Lachlan, secretary Government Railways of New South Wales, Sydney, New South Wales. Dear Sir,—Your two favours of the 27th November and the 7th December were duly received, but our reply has been unavoidably delayed. It is with the utmost regret that we have learned of the breakages of the engine and tender axles of the twelve 10-wheel passenger locomotives which were received last year per 'Henley.' The several reports sent us have received careful consideration. In contracting for these locomotives the commissioners desired to obtain engines adapted to unusually heavy service. In order to secure the utmost efficiency, and to obtain the best results of American experience, they left many of the details of the specification to our judgment. The material for the driving, truck, and tender axles was left optional, and as, in our opinion, the most satisfactory results are usually obtained from axles carefully forged from selected scrap iron, we ordered such axles from the manufacturer whose product we had been largely using with good results, and whose reputation for excellent work is generally recognised. No test was prescribed by us, as it is well-known that no test of scrap axles is conclusive. We relied upon their showing clean, uniform, well-worked material when turned up in the lathe. Steel axles, or axles forged from muck-bars can be tested under a drop with reasonable probability of the uniformity of the axles not tested, but the fact that a hammered scrap axle withstands such test is no guarantee that others of similar manufacture and appearance will stand. Not only have we been buying axles in this way for many years, but, so far as we know, it is the general practice in buying hammered scrap axles, both by railroads and manufacturers. These axle forgings did turn up clean, smooth, and free from flaws, and we supposed to be as good as the many hundreds which we have received from the same maker without one instance of failure coming to our knowledge. We go into the matter at this length to assure you that there was no conscious lack of diligence exercised by us to supply materials of the best quality, which your Government was entitled to receive from us. We have already replaced the twenty-four engine-truck axles with others of steel. We offer to reimburse the Government the cost of replacing the forty-eight tender axles. We also offer to pay the reasonable cost of the labour involved in effecting the replacement. We are of the opinion that the original dimensions of the truck and tender axles and journal bearings are ample for the fast speed for which the locomotives are suitable, provided the quality of the material is good; and the bearings for such engines have been widely adopted for similar service with good results. We should have much hesitation in increasing the diameter of the bearings with such small wheels, owing to the higher rotative friction. It should be borne in mind that the smaller truck wheels necessary in engines of this type require closer attention to the lubrication than the larger wheels used in English locomotives. If, however, large bearings are adopted, we urge the desirability of making them 5½in. rather than 6in. diameter. In view of the above we think the cost of new boxes, whether of iron or solid gun-metal, should not be charged to us, as we are certain that the replacing of the axles will prove a sufficient remedy. We remark that the driving axles were not made by the same party as the truck and tender axles. We therefore trust they will upon investigation prove satisfactory. There appears to be a clerical error in transmitting to our shopmen the dimensions of draw-hooks shown by your drawings. We authorise you to debit our account the cost of replacing them with stronger hooks. With these modifications we trust the engines will speedily show the special adaptation, which we believe they possess, to the difficult service for which they were ordered. That similar engines are doing such work on our American railways is shown by the recent test of our 10-wheel locomotives on the Baltimore and Ohio Railroad. Under separate cover we mail you three copies of the report of these tests. We trust these tests will in a measure justify the wisdom of the commissioners in the purchase of these locomotives, and that after the defective axles are replaced the performance of the locomotives will be such as to merit their entire approval.—Very truly yours,—(Signed)—BURNHAM, WILLIAMS, AND CO."

We gather from this letter that the builders were not obliged by the terms of their contract to test materials employed. This is, to say the least of it, a very unusual and old-fashioned policy. In the United States common puddled bars are known as muck bars, and the difference between really good scrap forgings, and forgings made by piling puddled bars and working them under a hammer, is enormous. We are astonished to learn from Messrs. Baldwin's letter that such axles seem to be used in American locomotive practice. No English engineer would be surprised to find that such axles break. It will be seen that the very small size of the bogie wheels renders the use of thick axles undesirable, for this reason more than usual care should have been taken to use a material whose excellence was not open to question. Mr. Eddy goes on—

All the cost of failures due to faulty workmanship has already, and without demur, been paid by the Baldwin Company, and we still hold a considerable sum of money belonging to the company in case any other weakness should develope. We deem it only right to say that we feel sure the Baldwin Company did not knowingly allow any defective material to be placed in the engines, and also to acknowledge the readiness with which they and their representatives in Sydney did all in their power to rectify defects.

Mr. Eddy then goes on to deal at some length with the strength of the permanent way. But this portion of his statement admits of being much condensed, and we have condensed it accordingly. His contention is that the road is amply strong enough to carry the Baldwin engines. Sir John Fowler's letter, which we give further on, settles, we think, the whole question. Mr. Eddy gives the following table to show that his road is not worse than others.

So far as the ordinary permanent way is concerned, the actual weight of the engine is of far less importance than that of the distribution of the weight upon the wheels. In the case of the engines under consideration the 58 tons which the engine weighs when fully loaded are distributed over five pairs of wheels and axles, and the weight upon any one axle and pair of wheels is less by 1 ton 2 cwt. than engines which have been running upon our lines for years past, and at a time when the roads were not in so satisfactory a condition as they are to-day. I have had prepared with a great amount of care a statement showing the weight of rail in use in other parts of the world, and the weight of engines run upon those rails, together with particulars of the weights borne by some of the driving-wheels, and this table will give a large amount of valuable and reliable evidence on the subject:—

Railway.	Total weight in working order. Engine.	Total weight in working order. Engine and tender.	Maximum weight on one axle.	Weights of rails per yard. Iron.	Weights of rails per yard. Steel.	Weight of steel rail per yard per ton on each wheel. Lightest rail.	Weight of steel rail per yard per ton on each wheel. Heaviest rail.	Remarks.	Authority for weights of engines.
	Tons cwt.	Tons cwt.	Tons cwt.	lb.	lb.	lb.	lb.		
Central of New Jersey	55 6	—	19 14†	56 and 65	62, 62½, and 70	6·3	7·1	Runs regularly 70 to 90 miles per hour.	*R.R. Gazette*, Feb. 12, 1892.
Baltimore and Ohio	59 8	93 6	15 14	60–80	67	8·5			,, Nov. 27, 1891.
New York Central	57 1	89 6	17 16†	None	65 and 80	7·4	9·0	Runs regularly. Empire State Express, fastest train in the world.	,, Sept. 18, 1891
Philadelphia and Reading	50 0	—	17 0†	None	56, 58, 60, 64. 68, 70, 88, and 90	6·6	10·6	Has run 91·7 miles per hour.	,, Nov 13 & 27, 1891.
C.C.C. and St. Louis	58 13	92 19	15 6†	Mostly steel	67	8·8			,, Jan. 1, 1892.
Erie	58 0	92 0	15 0† abt	—	56—65	7·4	8·7		,, June 13, 1890
Atchison, Topeka, and St. Fé	58 0	—	15 9†	(3095 miles)	56—65 (4015 miles)	7·2	8·4		,, Aug. 15, 1890
Chesapeake and Ohio	59 5	—	15 6	—	56, 62, and 75	7·3	9·8		*R. R. Journal*, July, 1890.
Master Mechanics	50 8	—	14 18†	—	—	—	—		*R. R. Gazette*, Jan. 8, 1892.
L. and N.W.R.	52 0	77 2	15 10	—	84–90	10·8*	11·6*		*Engineering*, Nov. 13, 1891.
North-Eastern	46 13	86 13	17 15	—	? 90	—	10·1*	Has attained highest speed (86 miles per hour) ever attained in England.	*R. R. Journal*, May, 1890.
Great Northern	45 3	78 11	17 0	—	82	—	9·6*	Runs fastest trains in England last 20 years.	*Engineering*, May 20, 1890.
N.S.W. (10-wheeled Baldwin)	58 7	90 6	15 5½	75	71, 75, and 80	9·2	10·4		
Eastern of France	£4 13	97 1	16 2	—	69—89½§	8·5	11·0	Running fast expresses.	*Engineer*, March 4, 1892.

* As this engine has the wheels and springs without equalisers, it is liable to have a considerably greater weight on the wheels.
† Average weight on each pair of coupled wheels.
§ The heavier rail has only been used of late years on parts of the line. The Engineer-in-Chief of the Permanent Way reports that 10 per cent. additional weight could be carried on the 69 lb. rail.

The ordering of the engines in question and the weight to be borne by each axle received the most anxious consideration at the hands of the Commissioners and their officers, before the order was given; but as a further increase in weight might become advisable in future years, I took the opportunity, when I was recently in the old country, of discussing the whole question with Sir Benjamin Baker and Sir John Fowler, two of the most eminent engineers in England. Sir Benjamin Baker unhesitatingly agreed that we could with safety carry 16 tons on one axle on a 70 lb. rail, with ironbark sleepers 9ft. by 10in. by 5in. placed 3ft. centre to centre. As Sir John Fowler, Bart., is our consulting engineer, I asked him to place his views in writing, which he did in the following terms:—"2, Queen-square Place, Queen Anne's Mansions, Westminster, S.W., October 22nd, 1891. New South Wales weight of rails. Dear Mr. Eddy,—The question you put to me yesterday with reference to the safety or otherwise of allowing locomotive engines with driving wheels having a weight of sixteen tons on a pair to work on your 70 lb. rails was an imported one, but I have no hesitation in answering it. Provided that the sleepers are of ironbark, 9ft. long by 10in. wide and 5in. thick, placed at a maximum distance of 3ft. centre to centre, and the line level, drainage, and the ballast well maintained, there is no objection or danger in the use of such engines for either passenger or goods traffic. Of course, I assume that the rails are renewed before they are worn and weakened, according to usual good practice, which may be said to be applicable to rails of all weights. But, at the same time, I should like you to understand quite distinctly, as my opinion, that with your present and certain increase of traffic, and the power and weight of engines you are practically compelled to use, a rail of 80 lb. per yard is more economical than one of less weight, from its higher percentage of wearing weight and its greater length of life before renewal. Believe me, yours very truly (signed), JOHN FOWLER." The Lancashire and Yorkshire Company have running upon their lines no less than 366 engines, with a weight upon a pair of driving wheels of from 15 tons 10 cwt. 1 qr. to 17 tons 10 cwt. The Great Western of England have engines carrying 15 tons 10 cwt., 15 tons 16 cwt., and 16 tons 10 cwt. on a pair of wheels. The Midland Railway Company carry 17 tons 10 cwt. on a driving axle of an express engine. The London and North-Western carry 15 tons 10 cwt. on each of the two pairs of driving wheels of Mr. Webb's new description of engine, Greater Britain. The Eastern of France, for the purpose of avoiding running two engines with their passenger trains, has just put to work an engine carrying 32 tons on the two driving axles—*i.e.*, 16 tons on each axle—their general rail being 69 lb. in weight. The chief permanent way engineer has also reported that the rail is capable of carrying 10 per cent. more weight with safety. This engine is to run at very high speeds. I will not detain the commission longer on this subject, as one of our officers will give evidence regarding the practice in America in running engines with as great a weight as 17 tons to 19 tons on one axle, at exceedingly high speeds, upon rails varying in weight from 56 lb. to 70 lb. Some stress has been laid upon the spacing of the sleepers upon the N.S.W. railways as compared with those upon English and American lines, and the question has been put in such a way as to lead the commission to believe that it is the prevailing practice in England to place the sleepers close together, and in New South Wales 3ft. to 3ft. 1in. apart, whereas the reverse is really the case. In dealing with the sleeper question, however, it must be borne in mind that this is not determined solely by questions of strength, but by the fact that a sufficient bearing area must be obtained for the rail on the sleeper, and the sleeper on the ballast, and the class of wood used. With the soft woods in use in Europe and America, it is absolutely necessary that the bearing-surface of the rail and the sleeper should be large enough to prevent the rail cutting into the sleepers. In England this is guarded against by using cast iron chairs, and in America by placing the sleepers close together. Even then continual trouble is experienced, in consequence of the rails and chairs cutting into the soft woods, which involves constant attention to prevent the road from becoming loose. The very exceptional ironbark sleepers we possess in this country are so hard and durable that the fastenings retain their hold exceedingly well for years, and the rail cuts but slightly into the timber. The question of durability is also very important. The uncertain quality of the timber used for sleepers in America renders it necessary for a larger number to be used as a matter of precaution. A most important point to be considered in connection with permanent way is the weight of the road, as compared with that of the rolling stock passing over it, as the weight of the road as a whole measures its resistance to the blows of the traffic. The following statement shows the weight of a mile of permanent way of our three types of road, as compared with the standard main line of a leading railway company in England:—

Weight of One Mile of Permanent Way.

		t.	c.	q	lb.
New South Wales	75 lb. D.H. iron rails laid in 27 lb. cast iron chairs upon ironbark sleepers 9ft. long by 10in. by 5in., 3ft. apart centre	384	7	3	11
	71½ lb. T steel rails laid upon ironbark sleepers, 8ft. long, 9in. by 4½in., 2ft. 7½in. and 2ft. 8in. centres	282	2	2	15
Wales	71½ lb. T steel rails laid upon ironbark sleepers 9ft. long, 10in. by 5in., 2ft 7½in. and 2ft. 8in. centres	346	8	1	11
	80 lb. T steel rails laid upon ironbark sleepers 9ft. long, 10in. by 5in., 2ft. 7in. centres	371	1	3	1
English	L. and N.W.R.—84 lb. bull-headed steel rails laid in 45 lb. cast iron chairs upon creosoted Baltic sleepers, 9ft. long, 10in. by 5in., 3ft. apart centres	344	1	1	4

The weight of the standard Baltic timber sleeper in general use on the best lines in England, 9ft. long by 10in. by 5in., creosoted, is 160 lb., and that of our ironbark sleepers of similar dimensions is 252 lb. As regards durability, the life of the ironbark sleeper may be taken at fully double that of the former; I fancy a great deal more, but I want to be within the mark. In the evidence brought in support of the charges, the rails on the New South Wales railways have been spoken of generally as being laid on sleepers 3ft. to 3ft. 1in. centre to centre; whereas out of our total mileage of 2180 miles, on no less than 1650 miles of the road the sleepers are placed 2ft. 7in. to 2ft. 8in. centre to centre on the straight. On the old road, where the sleepers were placed 3ft. centre to centre in the straight, the road on curves was strengthened by additional sleepers, the rule having been to place the sleepers as close as 2ft. 4in. centre to centre in sharp curves of less than 15 chains radius, and 2ft. 9in. in curves of from 15 to 30 chains radius. It has also been represented that only a few miles of steel rails heavier than 71½ lb. to the yard exist on our lines, whereas since the commissioners have been in office no less than 215 miles of line have been laid with 75 lb. and 80 lb. steel rails, and an additional 55 miles with 71½ lb. steel rails. In regard to improving the ballasting of the lines, no less than 700,000 tons of ballast have been used; out of that quantity 600,000 tons have been blue metal, hard quartz, or slag. In regard to the ordinary repairs to the permanent way, it may be mentioned that for relaying alone there has been paid out of working expenses during the three and a-half years the commissioners have been in office, £230,000. During the fifteen years preceding the commissioners taking office, a sum of £195,000 was paid for the same purpose. This and other important work has been done, and the working expenses reduced by over 5 per cent. per annum. As practically the whole of the Baldwin engines are working on the Western line, it will be well to detail the improvements made on the oldest section—Granville to Bathurst—a distance of 132 miles, of which 25 miles are double

line. During the past three and a-half years no less than 45 miles have been relaid, and more than 60 miles completely reballasted and lifted, while on the remaining portion a very large amount of lifting and slight reballasting has also been done. Before the close of the year we expect that the whole of the rails on the Western line—Sydney to Bourke—503 miles, will be of steel, varying in weight to the yard 71½ lb., 75 lb., and 80 lb.

Mr. Eddy concluded by stating that he proposed to call witnesses to prove his case, and at this stage the proceedings were adjourned. Mr. Eddy has no doubt made a powerful defence, but it must not be forgotten that only one side has been heard by our readers. No one, we ourselves least of all, assert that the Baldwin engines are not powerful and efficient. They ought to be, considering their dimensions. The three questions to be decided are:—Is it certain or even probable that they are the very best engines that could be got for the purpose? Is there any reason to think that better engines could not have been supplied for less money by English firms? And lastly, was sufficient care taken to insure that the best materials and workmanship would be put into the engines? The decision of the Commissioners on these points will be awaited with interest on both sides of the Atlantic.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE closing Midland exchanges of the half-year, in Birmingham to-day and in Wolverhampton yesterday, were not characterised by as much cheerfulness as when the year opened.

The retrospect indulged in by some business men was not calculated to inspire reassuring feelings. The fact was recalled that, when 1892 set in, prospects were somewhat improved compared with the previous position. The low bank rate, the better South American outlook, and the accounts of a possible trade revival in the United States—these were circumstances which induced hopeful anticipations.

Labour disturbances have, however, marked the six months, both at home and abroad—in the former case by strikes and lock-outs, and in the latter by financial and political complications. The result has been that the industrial promise of the early days of the year has not been fulfilled, and at the close of the first six months Midland business men—like those of most other districts—are hardly more forward than when January set in.

Those who have watched the returns of the railway companies during the half-year cannot but have noted the decreasing receipts consequent upon the falling off of the goods traffic, and it seems probable that, with one or two exceptions, most of the leading companies will be declaring a reduction on last year's dividend of from ¼ to ½ per cent.

The influence of the Parliamentary election contests is also felt.

Anticipations of progress are, however, entertained when the difficulties which just now are crippling the purchasing capabilities of some of our foreign customers have been removed.

Galvanised iron manufacturers quoted yesterday £11 10s. to £11 15s. for 24-gauge corrugated sheets, f.o.b. Liverpool in bundles. They state that they experience a continuance of the revival which lately has taken place in business with the Argentine, but Brazilian orders are somewhat under the average. Chili is better, and a little more is doing with India. The high price of spelter is, however, still complained of.

Marked bars are in fair demand. The basis price remains £8. For merchant sorts about £7 is asked, and for common £5 12s. 6d. upwards.

Hoops are quoted £6 12s. 6d., with a rather better business of late with the United States.

Plain sheets are in tolerably good demand for working-up purposes, but galvanising qualities, which are quoted about £6 17s. 6d. for singles, £7 to £7 5s. for doubles, and £7 17s. 6d. to £8 for trebles, are not in good request.

Deliveries of crude iron under old contracts are being concluded satisfactorily, and inquiries are being received preparatory to arranging for fresh supplies, but not much actual new business is just yet forthcoming.

Staffordshire all-mine hot blast pigs are quoted 62s. 6d.; part-mines, 44s. to 45s.; and cinder sorts 37s. 6d. For Lincolns 47s. is asked, for Derbyshires 43s. 6d. to 44s. 6d., and for Northamptons 44s. 6d. to 45s. 6d. Good West Coast hematites delivered are about 58s. 6d.

Among the heavy industries, a considerable amount of work is under execution by the ironfounders, and the engineers are regularly employed. A good weight of iron hurdles and fencing of various kinds is being produced, and the light ironfounders report a steady influx of orders, which find fairly constant work for the employés.

In the wrought iron tube branch there is considerable depression, and most of the works devoted to this industry are at little more than half production. German competition in this branch is very active.

Seamless steel tube makers have had an excellent season so far, but business is now slackening, as the wants of the cycle manufacturers are becoming satisfied.

The numerous builders' strikes in different parts of the country continue to interfere with the demand for tools and constructive fittings; but the railway companies are doing fairly well, and there is a considerable amount of work under execution still for the Admiralty and the War-office.

Local merchants and manufacturers are much concerned at the progress of the United States scheme for obtaining preferential terms in various neutral markets by means of reciprocity treaties. At a meeting of the local Chamber of Commerce recently, attention was called to the treaty newly concluded between Spain and the United States, in virtue of which the latter country obtains free entry into the Spanish West Indian colonies for manufactured products which have hitherto been obtained from this country. Strong representations on the subject have been made to the British Foreign-office, but the Birmingham Chamber are not prepared to advocate a policy of retaliation, as recommended by the Tariff Committee.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Business continues to drag on in a very unsatisfactory fashion, with buying restricted to the smallest possible quantities for immediate requirements. Although makers and manufacturers of pig and finished iron are already for the most part working at an actual loss, there is a very general belief that prices will have to be lower, and merchants in some instances are certainly acting up to this belief by the eagerness they show to sell forward at considerably under current quoted rates. Makers' prices for prompt delivery still show firmness, as some brands of pig iron continue very scarce, but there is so little doing that prices are scarcely tested, and even for practically immediate delivery there is plenty of iron to be bought through second hands at under makers' quotations. Whether prices will give way to any material extent, of course, remains to be seen. In some degree the mere question of cost would seem to preclude the possibility of makers coming down lower, but the depressed condition of most of the iron-using industries presents a very discouraging prospect, and the position of producers, both of raw and manufactured material, becomes one of increasing difficulty.

The Manchester Iron Exchange on Tuesday was fairly well attended, but there was little or nothing of any moment being put through, inquiries for the most part, both in pig and finished iron, being only of a small hand-to-mouth character. Lancashire makers of pig iron still quote on the basis of 44s. 6d. for forge to 45s. 6d. for foundry, less 2½ per cent., delivered equal to Manchester, but their present very small production scarcely influences this market, and the business they are doing is practically confined to limited transactions with regular customers in the more immediate neighbourhood of their own works. With regard to district brands, although several of the leading makers are still practically out of the market, prices, if anything, are not showing quite the firmness noticeable recently, and there are low sellers in the market, both of Lincolnshire and Derbyshire. Lincolnshire iron could be bought at about 43s. 6d. and 44s. for forge, to 44s. 6d. and 45s. for foundry, less 2½, delivered in Manchester, although one or two makers would want 6d. to 1s. above these figures; Derbyshire ranges from about 45s. for forge, up to 47s. 6d. and 48s. 6d. for foundry, according to brand, less 2½, delivered here. In outside brands prices have been irregular, according to the position of sellers, but the fluctuation in warrants has had no appreciable effect upon this market. With the continued scarcity of Middlesbrough iron, quotations for prompt delivery are still firm in some cases, at 49s. 10d., net cash, as the minimum, equal to Manchester, but for forward delivery there are sellers at quite 1s. 6d. per ton under this figure. In Scotch iron merchants continue low sellers, and for delivery at the Lancashire ports, Govan could be readily bought at 45s., Carnbroe 46s., Eglinton 47s., and Glengarnock at 48s. 6d., net prompt cash, with makers asking about 6d. above these figures.

The manufactured iron trade remains in very much the same position as reported for some time past; some of the forges are kept fairly well employed, but it is only from hand to mouth, and there is no weight of work ahead. Prices, if anything, tend in the favour of buyers, and £5 15s. to £5 17s. 6d. represent about the average prices for Lancashire and North Staffordshire bars, delivered in the Manchester district; with underselling in some instances even at these low quotations. Ordinary merchant sheets average £7 5s. to £7 7s. 6d., and hoops £6 5s. for random, to £6 7s. 6d. for special cut lengths, delivered here.

In the steel trade business continues quiet all through, and in raw material prices show a further weakening tendency, good foundry hematites being now readily obtainable at about 58s. 6d., less 2½, and steel billets at £4 12s. 6d. to £4 15s., net cash, delivered in the Manchester district. In steel boiler plates there is only a limited inquiry, although for specified prompt delivery special prices are still quoted, local makers asking £7 17s. 6d. to £8 per ton, equal to Manchester, but ordinary forward contracts can be placed at comparatively low figures. Some of the Scotch steel boiler plates are quoted at £7 5s., and £7 7s. 6d. to £7 10s. would represent the full average prices upon ordinary business for forward delivery to consumers in the neighbourhood of Manchester.

In the metal market business continues of a very unsettled character, owing to the fluctuations in the raw material, but list rates for manufactured goods remained unchanged.

No material change can be reported with regard to the engineering industries; it is only in a few exceptional cases where a fair weight of new special work is coming forward, the reports generally being still to the effect that there is a decided tapering off all through. Many of the local engineering works are but very indifferently supplied with orders, and in not a few cases they are already extremely slack. There has been a good deal of talk recently in the district about the necessity of reducing wages, but so far no definite movement in this direction has been actually set on foot, although it is very probable that the question will further on be brought forward for serious consideration.

Messrs. John Wild and Co., of Oldham, are introducing a new process for forging and rolling steel balls for ball bearings, that are now being so largely adapted in connection with various descriptions of machine tools; by the new process they are practically hammered balls, and it is claimed that the process is a very great improvement upon existing methods of manufacture. Not only will the production be very largely increased, with a less amount of labour, but an important feature is that the waste of material that is at present involved in the manufacture of steel balls will be altogether avoided, there being, in fact, no waste of material whatever by the process which Messrs. Wild and Co. are introducing.

Only a very quiet demand is reported for all descriptions of round coal, inferior qualities for ironmaking, steam, and general manufacturing purposes, especially, being difficult to move, owing to the depressed condition of most of the coal-using industries. With the present restricted output, collieries not working more than four to five days per week, there is no large accumulation of stocks, and prices for the most part are being fairly well maintained, but in common round coals surplus quantities are being pushed for sale at under nominal list rates, and for shipment, especially, very low prices have been taken. At the pit mouth best coals average 12s., seconds, 10s. to 10s. 6d., common house-fire coals, 8s. 6d. to 9s., and steam and forge coals, 7s. 6d. to 8s. per ton. For shipment, common steam coals have been offered at as low as 8s. 6d. to 8s. 9d., delivered at the ports on the Mersey, but for better qualities about 6d. above these figures is still being quoted. Engine classes of fuel continue in brisk demand, and with rather a scarcity of supplies there is a decided hardening tendency in prices, advances of 3d. to 6d. per ton being quoted in some instances. At the pit mouth common qualities of slack are not now quoted under 3s. 6d. to 4s., medium sorts average 4s. 6d., with better qualities fetching 5s. 6d., and ordinary descriptions of burgy average about 6s. 6d. per ton.

Gas coal contracts are being settled only very slowly, and Yorkshire colliery proprietors are now competing here very keenly for any business that is to be secured. I hear of quotations for tenders sent in at prices which do not leave more than 8s. per ton at the pit mouth for good screened Yorkshire gas coal, which is about 9d. to 1s. under last year's price. As regards Lancashire gas coal, it is very exceptional where concessions of more than about 3d. per ton have so far been obtained upon last year's prices, and at the pit mouth 10s. per ton represents about the average quotation for good Lancashire screened gas coal. One or two contracts for moderate quantities of locomotive fuel have been placed recently at prices about 3d. to 6d. per ton under those of last year, which is a substantial improvement upon the prices accepted for contracts a short time back placed with the London and North-Western Railway Company.

Barrow.—With a good supply of coke from the East Coast, smelters of iron in this district have very materially increased the number of furnaces engaged in the production of hematite pig iron. At Barrow the whole of the twelve furnaces that were blowing before the strike are now again actively employed, and in Furness and West Cumberland there are now a matter of thirty-four furnaces in active blast, as compared with forty prior to the Durham difficulty. As the production has increased and the demand of buyers who had long-standing orders satisfied, there is a somewhat quieter tone noticeable. The general demand is not by any means good, and is chiefly confined to local steel makers, who have re-commenced operations, but buyers on home account generally and Continental account are not in want of supplies of iron. Makers are busy in the completion of old orders, and are not, in some cases, ready to do business for prompt delivery, and at the same time buyers do not show any inclination to place for future delivery, and the sales since the finish of the strike are not large.

Hematite warrants have decreased in value, and are now quoted at 49s. per ton net cash, while makers are asking 50s. to 51s. per ton for mixed numbers of Bessemer iron net f.o.b. The stores of warrants are still being cleared, and this week the returns show a decline to the extent of 3113 tons, which leaves 45,215 tons still held, or a decrease of 98,872 tons on the year.

The steel trade is much more active. At Barrow nearly the whole of the mills have been re-started, some three months' work being held. There is, however, not very much new business offering, and the orders being placed are not large. Rails are very quiet, and are at £4 4s., £5 15s., and £6, for heavy, light, and colliery sections respectively. The inquiry for steel shipbuilding material keeps fair, but is confined to local and Belfast buyers chiefly. Prices are steady at £6 2s. 6d. for plates; £5 15s. for angles; and £6 12s. 6d. for boiler-plates. There is next to nothing doing in the other descriptions and sections that are manufactured here, and prices are as follows:—Hoops, £7; tin-plate bars, £4 5s.; blooms £4 1s. 3d. to £5 1s. 3d.; wire rods, £6 12s. 6d. to £6 15s.; and slabs and billets at £4 5s. to £4 10s. each.

Shipbuilders are busy and are in negotiation for some new orders, which will, it is expected, be placed soon. Engineers have plenty of work in hand.

Iron ore is in fair demand at 9s. per ton, net at mines.

East Coast coke is at 22s. per ton, delivered here.

The shipments for the week represent 9262 tons, as against 23,333 in the same week of last year—a decrease of 14,071 tons. The exports to date represent 341,207 tons, as against 498,279 tons last year—a failing off of 157,072 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

A QUIET period is now looked for in the coal trade. The weather continues sultry, though variable, the General Election is in full swing, and the Durham men are back to work. All these causes contribute towards diminished business in household fuel. A much lighter tonnage is being sent to London, and less is called for by other markets. A fall in prices is absolutely certain, although the reduction may be retarded by the smallness of stocks. These are generally lower than they have been for years. Prices of Silkstones are now at 11s. to 12s. per ton; Barnsley house, 10s. to 10s. 6d. per ton; other qualities, 8s. 6d. to 8s. 9d. per ton. Steam coal is now at its briskest stage, the tonnage taken by Hull and the other great Humber ports being quite as heavy as in 1891, the five days' week making no appreciable difference in the output. The value of this class of coal ranges from 9s. to 9s. 6d. per ton. Less is doing in gas coal, and somewhat lower prices are accepted. Manufacturing fuel, for which there is a fair request, remains at 5s. to 6s. a ton. Small coal and smudge are also fairly sold.

A fair demand is maintained for coke, the ovens being well employed. Some of the makers of Durham coke report a reluctance to renew contracts. Business, they say, is returning to the North very slowly, and some of it has been drifted, probably permanently, to other quarters. South Yorkshire coke, in its finest qualities, was undoubtedly in greater demand through the Durham strike. How gravely the stoppage in the North affected railway interests is brought out by the diminished traffic returns of the North-Eastern Railway Company, which show a large falling off on the average.

There is not much to complain of in the amount of business done in the iron and steel trades. The majority of the furnaces having now got into blast, supplies of hematite irons are more easily obtainable, quotations remaining as before. There will be no change now until the general election is over, and the quarterly ironmasters' meetings have been held. A very good business is being done in steel, particularly in the case of firms who are well in with leading manufacturers of machinery and general agricultural specialities. A considerable pressure is reported from these establishments. For lower grades of steel there is excessive competition, and the orders on the market are rather under what was anticipated. A better business has been done of late in crucible steel for the United States.

The engineers in this district are watching with interest the movement for reductions of wages in the North. It is reported that the engineers of Northumberland, Durham, &c., are asked to concede from 5 to 10 per cent. If this movement succeeds, it will no doubt extend to the Sheffield and South Yorkshire district, where some 18,000 men would be affected.

Depression generally prevails in the lighter industries. Our leading cutlery house—Messrs. Joseph Rodgers and Sons, Norfolk-street—have requested the men in the pen and pocket department to concede a reduction in wages. At the beginning of last year a similar proposal was made. This was stubbornly opposed by the men, and the firm, refusing to stock at the existing rate of wages, gave out no work except for actual orders. Since that time trade has still further attenuated, particularly in India, China, and some of the Colonial markets. The Indian market has perhaps suffered most severely through the competition of German houses shut out of the United States by the McKinley Tariff. In the silver and plating establishments there is a corresponding stinting of work. Less is also reported in the file trade. One or two houses are better off, the new work placed with them being mostly for hand-cut files.

The Hon. G. R. Dibbs, Prime Minister of New South Wales, visited the Cyclops Works—Messrs. Charles Cammell and Co.—on Tuesday. The Premier and party were conducted over the establishment by Mr. Alexander Wilson, J.P., the managing director. The visitors were keenly interested in the rolling and casting of a compound armour plate, on the principle patented by Mr. Wilson. It weighed about 50 tons, and is intended for the barbette of H.M.S. Royal Oak. The operations of steel manufacture by the Bessemer process, file cutting, and other departments of work. were also witnessed.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

WHAT with electioneering, the rapid rise in prices of Middlesbrough warrants, and the scarcity of iron, business has been very limited this week, though it might have been larger if the sellers had not held back so much. The fact is that holders of Middlesbrough warrants now have a better opportunity than has come for years of securing higher prices, and they are not neglecting to avail themselves of it. There has sprung up a strong demand for Cleveland pig iron warrants, for it appears that a number of Glasgow "bears" sold them forward pretty heavily some time ago, and delayed covering, as they and all other people believed that prices would fall when the Durham strike terminated and operations were resumed at the furnaces. It seemed to be good policy for buyers to wait, but it has not yet proved to be so, because prices have advanced instead of the opposite, and now when it has become necessary to deliver the warrants sold—and heavy quantities are due for delivery to-day and Monday—they are not to be obtained, though as much as 45s. per ton was offered on Tuesday, a price 4s. above that which ruled last week, and there were no sellers to be found either on Tuesday or Wednesday. The "bears" are thus in an unenviable position, and holders of warrants have thus the upper hand. They are better able to insist upon higher prices than they have been for long enough, for there are less than 40,000 tons in the public warrant stores, and this is in the possession of a very few firms only—indeed, one firm holds the greater part. Thus sellers of Middlesbrough warrants can now act with something like unanimity, which they could not do when the scrip was held in many hands, a few thousand tons here and a few thousand there. The position of sellers is also strengthened, because maker's iron does not compete, seeing that the producers hold no stock of No. 3—which is the quality that is required for

storing purposes—and they are making very little, while that little does not come on to the market, because it has to be delivered to consumers in satisfaction of contracts which were entered into before the Durham strike. The bears would readily purchase No. 3 Cleveland pigs if they could get it, simply in order to convert it into warrants and so relieve themselves from the difficulty under which they are now labouring, but they cannot secure the iron, and so the warrant holders are the masters of the situation for the present. The "squeeze" has been altogether in Middlesbrough iron, for there has been no movement either in Scotch or hematite, and it arises altogether from speculative operations. Unfortunately for the makers, they are not deriving any benefit from the higher prices, as they have to deliver the iron they produce to consumers, who are paying 5s. or 6s. per ton below the rates now ruling. The demand is an altogether prompt one, and when makers have any iron available for sale it is probable that they will have to accept considerably less than is now being paid, indeed nearly 3s. less is offered for deliveries July-September.

Middlesbrough warrants, which last week could at one time be got for 41s., went up to 42s. 6d. on Tuesday, and sellers refused to let any more go, even though they were offered 45s. for them. It has been a remarkable feature of this week's market that small lots of pig iron have been cheaper than larger parcels. The buyers wanted the iron to put into the public warrant stores, and lots of under a hundred tons were of no use for this purpose, so that so much would not be given for them. Thus only 41s. could be obtained for lots of, say, fifty tons each, but for parcels of a few hundred tons 41s. 6d. had to be paid, and that had also to be paid for iron for shipment. For delivery over the third quarter of the year 39s. 3d. would have been accepted—a circumstance showing that the opinion is that prices will become more favourable to buyers. No. 4 foundry pigs are still in small production, but the demand for them also is very slack, as Scotland, which is the chief consumer of this quality of iron, has almost ceased to take it from Cleveland because it is too dear, and suitable iron at a considerably lower price can be had from the Scotch furnaces. Very little Cleveland iron now goes to Scotland; up to Tuesday night the quantity for June only reached 5090 tons, as compared with 34,535 tons in June, 1891, to the 28th, and the quantity is not half of what it was even in May. No. 4 forge can now be got at 39s. for prompt delivery, and 6d. less for forward. Pig iron shipments for June have been about the poorest on record, not much over 30,000 tons; whereas if trade had been good, they should have been nearly thrice that quantity. Local hematite is quoted 50s. per ton, for mixed numbers. Another cargo of Spanish pig iron has been imported into the Tees, the Marquis de Mudela—a Spanish steamer—delivering 2500 tons at Connal's Wharf, Middlesbrough. During June not a single ton of Spanish iron ore was delivered to any of the furnaces on Tees-side, a circumstance which may be characterised as unprecedented since hematite began to be made in the district. In ordinary times over 100,000 tons are imported each month. Hematite pig iron makers have been consuming the stock which accumulated during the early part of the Durham strike. The stock of pig iron in Connal's stores on Wednesday evening was only 40,048 tons, or 23,211 tons decrease for June. The decrease in the warrant stores has become less rapid, only 1044 tons being taken out this week.

Since last week the following furnaces have been restarted:—Clarence, 2; Acklam, 3; Cleveland, 3; Smithbank, 2; Clay-lane, 1; Tees, 1; Newport, 1; Seaton Carew, 2; in all 15, and there are now 73 at work, against 83 blowing when the Durham strike commenced. But very few of the furnaces, have as yet been able to produce No. 3 quality, and those that have, have made it irregularly. The qualities mostly made are white, mottled, and grey, and at a number no saleable iron has yet been obtained, the furnaces turning out slag, or iron that is so bad that it has to be thrown back into the furnace. Thus it is probable that the June production will not be over an eighth of what it was in the months previous to the stoppage.

The manufactured iron and steel producers expect quieter times, because orders are coming in very badly in all departments, and those who furnish the orders are themselves getting badly off for work. Contracts on the books keep the establishments that have started after the strike fully in operation, but this can hardly be expected to continue, as the dulness in demand is undoubtedly increasing. The rail makers report a poor trade, and an equally unsatisfactory outlook, for neither at home nor abroad do railway authorities seem disposed to buy, even though £4 per ton at works for heavy rails will be taken. The quotations for other descriptions of manufactured iron and steel are: Common bars, £5 10s.; best bars, £6; iron ship plates, £5 7s. 6d.; iron boiler plates, £6 7s. 6d.; iron girder plates, £5 12s. 6d.; iron ship angles, £5 2s. 6d.; iron engineering angles, £5 7s. 6d.; steel ship plates, £5 17s. 6d.; steel boiler plates, £6 17s. 6d.; steel ship angles, £5 12s. 6d., all less 2½ per cent. discount and f.o.t. at producers' works.

Engineering is a good deal quieter than it was, as is also shipbuilding, and it is apparent that the latter half of the year will be a less favourable period even than the first half has been. The secretary of the Boilermakers and Iron Shipbuilders' Association reports to the men that shipbuilding prospects are not bright, and that the members out of employment were 9·6 per cent. of the whole in June, as compared with 8 per cent. in May, the expenses being £1077 per week, against £969 12s. in the previous month. With freights so low and remunerative employment so scarce, it is natural to look for fewer orders for new ships and for new engines. Trade has become so bad that the employers in the engineering industries of the Tyne and Wear have given notice to the men in all branches, including fitters, erectors, millwrights, planers, holders-up, screwers, brass finishers, joiners, smiths, plumbers, strikers, platers, rivetters, slotters, flangers, and the members of the Boilermakers and Iron Shipbuilders' Society engaged in the engine shops—in all some 20,000 men—that wages are to be reduced 10 per cent. To a considerable extent the men may thank themselves for this, because their strike of thirteen weeks drove away a large amount of trade to other districts, and even work that had been begun on Tyneside had to be finished elsewhere. To secure more orders the employers have to quote lower rates, and this necessitates their bringing down wages. Mr. William Allen, of the Scotia Engineering Works, Sunderland, who adopted the eight hours' day last January, now declares the system to be an unqualified success. When the plan was adopted, the men agreed to a 5 per cent. reduction in wages as a safeguard against loss to the employer, but Mr. Allan has been enabled to restore the old rate of wages, as there is no loss. The principal feature of the new plan is that work is commenced at a later hour in the mornings, and there is no stoppage for breakfast. Mr. Allan says there is no "sleeping in" now, and only one break in the day instead of two, time being thereby saved.

At West Hartlepool Messrs. William Gray and Co. have launched the Alberta, of 7300 tons deadweight carrying capacity, the largest cargo carrying vessel afloat. Engines to drive the vessel 10 knots per hour are to be supplied by the Central Marine Engineering Co., West Hartlepool.

Among the local candidates for Parliamentary honours in the new House of Commons are:—Mr. Hugh Bell, ironmaster, Clarence Ironworks, Middlesbrough (for Middlesbrough); Mr. Thomas Wrighton, engineer and ironfounder, Teesdale Ironworks, South Stockton (for Stockton); Mr. Thomas Richardson, marine engineer, of Thomas Richardson and Sons, West Hartlepool (for Hartlepool); Mr. Theodore Fry, of Fry, Janson, and Co., Rise Carr Rolling Mills, Darlington (for Darlington); Sir Jas. W. Pease, Bart., colliery owner (South-West Durhan); Mr. Joseph Richardson, iron shipbuilder, Stockton (South-East Durham); Mr. Henry Fell Pease, colliery owner, Darlington (for Cleveland); Mr. A. J. Dorman, iron and steel manufacturer, Britannia and West Marsh Rolling Mills, Middlesbrough (for Cleveland); &c.

The Northumberland coalowners have intimated to the miners that they cannot see their way to grant the 10 per cent. advance of wages claimed by the miners, for realised prices have fallen since wages were last adjusted in November.

The failure of the Bill which was to give powers to the North-Eastern Railway Company to acquire the Hull Docks, has given no little satisfaction to traders in the Tyne, Wear, and Tees, who have viewed the measure with some apprehension, as they expected the trade of Hull would be fostered to their detriment.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been comparatively little inquiry for ordinary iron in Glasgow market this week, and hematite has been almost entirely neglected. The feature of the business was a scarcity of Cleveland warrants, and as there has been an oversold account in this class of iron, prices have gone up rapidly against the "bears." Cleveland has been sold at 42s. 6d. for delivery this week, while Scotch iron has been 1s. per ton cheaper. Usually, Cleveland is at least 5s. cheaper than Scotch, and in point of fact it can now be purchased for delivery three months hence as low as 36s. per ton. The lighting-up of so many furnaces in Cumberland has reduced operations for the time in hematite warrants.

The following are the prices of makers' iron:—G.M.B., f.o.b. at Glasgow, Nos. 1 and 3, 42s. 6d. per ton; Monkland, No. 1, 43s. 6d.; No. 3, 42s. 6d.; Carnbroe, No. 1, 44s. 6d.; No. 3, 43s. 6d.; Clyde, No. 1, 48s.; No. 3, 47s.; Gartsherrie, Summerlee, Langloan, and Calder, Nos. 1, 50s.; Nos. 3, 48s.; Coltness, No. 1, 53s. 6d.; No. 3, 49s.; Glengarnock, at Ardrossan, No. 1, 50s.; No. 3, 47s. 6d.; Dalmellington, No. 1, 47s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 46s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s.; No. 3, 50s.; Carron, at Grangemouth, No. 1, 54s.; No. 3, 47s. 6d.

The pig iron shipments from Scottish ports in the past week amounted to 7514 tons, compared with 5235 in the corresponding week of last year. Italy took 1742 tons, Canada 660, United States 130, India 135, Australia 185, France 30, Germany 110, Russia 200, Belgium 50, China and Japan 380, other countries 240, the coastwise shipments being 3482 tons, against 1693 in the same week of 1891.

The output of pig iron is unchanged, there being 74 furnaces in blast, compared with 72 at this time last year.

There is comparatively little movement in the steel trade, few fresh orders coming to hand. The works that are in operation, however, are steadily occupied with orders for current delivery. Several additional steamers have been placed with Clyde shipbuilders, and the steel required for these has been in process of negotiation. Makers adhere pretty closely to former prices, and the quotations are on the basis of £6 3s. 9d. to £6 5s. for shipplates, less 5 per cent. discount, for delivery in Glasgow district.

The past week's shipments of iron and steel manufactured goods from Glasgow embraced locomotives to the value of about £11,000; sewing machines, £58,160; machinery, £13,800; steel goods, £12,600; and general iron manufactures, £21,100.

The malleable iron trade presents scarcely any new feature of interest, business is very slow all round, and yet it is remarkable how small lots turn up to keep the works going. There is little prospect of an improvement in business until the beginning of autumn. Makers quote the lowest grade of common bars £15 15s.; second grade, £6; highest grade, £6 2s. 6d.; best bars ranging from £6 5s. to £6 12s. 6d.; angles, £5 12s. 6d.; nail rods, £6; sheets, £7 7s. 6d.; all subject to the usual 5 per cent. discount.

There is an easier feeling in the coal trade. The miners are turning out as large supplies as during the Durham strike, and the market is accordingly somewhat heavy. Some extra demand has been experienced from the Clyde to Mediterranean ports, but the bulk of the trade is of a prompt description. The prices f.o.b. at Glasgow are:—Main coal, 7s. 6d. to 7s. 9d.; splint, 8s. to 8s. 3d.; ell, 8s. 3d. to 8s. 6d.; and steam, 10s. to 10s. 3d.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE great event of the week has been the adjourned debate at Aberdare on the sliding scale agreement. It will be remembered that at a late meeting it was resolved by the colliers' delegates that a vote by ballot should take place at each colliery, the colliers to vote for or against putting in notices on July 1st to terminate the sliding scale in six months' time. The voting has now taken place, and it was recorded at the meeting on Monday that 37,529 colliers had decided against the scale, and 26,021 in favour. This showed a majority for putting in notices to terminate of 11,502, and notice has accordingly been given, and December next will bring on another industrial crisis and possibly a conflict. But there are some features in connection with the voting which are satisfactory. The large number in favour, though in the minority, represent the common sense and thoughtful of the colliers, and should not be swamped by the majority, who are principally the young men who have had no experience of strikes and their calamities. This is the view taken by the delegates; and a further voting is to take place, the ballot paper to take this form:—"(1) I am in favour of suspending the sliding scale principle, and joining the Miners' Federation. (2) I am in favour of forming a powerful organisation, which shall embrace the colliery workmen of South Wales and Monmouthshire, and in favour of the sliding scale principle as regulating wages." Thus the collier is now to say whether he will support the Miners' Federation, or go in unitedly for a re-arrangement of the sliding scale. It is to be simply scale or no scale.

It is satisfactory to the supporters of the scale principle to note that many large collieries showed a majority in favour of continuing the scale. Thus Deep Duffryn gave 353 in favour and 233 against; Forchaman, 240 for and 174 against; Dinas, 545 for and 110 against, and others more or less. This fact gives a little hope that a conflict will be avoided, and that after another series of "sittings" a new scale may be adopted.

The depression in coal continues though large exports are going on, and prices are gradually getting lower. Best steam was quoted at Cardiff midweek at 11s. 9d. to 12s. 3d.; seconds, at 11s. 3d. to 11s. 6d.; inferior, 10s. to 10s. 9d. Small, which has also been been getting weaker, is at 5s. 6d. House coal remains a little firmer than steam, probably in consequence of the variable weather. At all events, the best is still at 12s. 6d., and best Rhondda 12s. 3d.; brush is at 9s. 9d., and small 8s. 3d. to 8s. 6d. In coke there has been a slight improvement over last week. Prices at one time seemed to be on the point of tumbling down when the Durham strike ended, but the excellence of Welsh coke seems to have prevented this, and the drop has not been continued. Prices this week are: furnace, 18s. to 18s. 6d., and foundry, 21s. 6d. to 22s. 6d., Cardiff.

The steel trade seems to be brightening a little as the sister industry declines. This may in part be explained by the cheapening of raw materials. Orders for rails, bolts, plates, and steel bar are fairly numerous. What the ironmasters chiefly suffer from is a plethora of pig iron. In particular, Dowlais and Cyfarthfa hold great stocks, but it is a favourite tradition at Cyfarthfa to make pig freely when wages are low, and the venture is almost always successful.

The Sliding Scale Committee of the steel trade decided on Saturday at their meeting, held in Merthyr, that a reduction of wages must take place on and from July 1st to the extent of 2 per cent., bringing wages to the standard. This scale is also doomed, as reported by me lately. Neither colliers nor ironworkers favour a scale which is inaugurated by a series of reductions.

The principal staple in the steel trade continues to be steel bar for the tin-plate works, and judging from the orders in hand, and the pressure to get orders booked for future delivery—which ironmasters are rather chary in accepting—the prospect is improving.

The following quotations ruled on the Exchange, Swansea, midweek:—Glasgow pig, 41s. 6d.; Middlesbrough, 42s. 6d.; hematite, up to 49s.; Welsh bars, £5 5s. to £5 7s. 6d.; steel rails—heavy, £4 2s. 6d. to £4 5s.; light, £5 5s. to £5 10s. Iron and steel sheets remain. Bessemer steel: tin blooms, £4 7s. 6d. to £4 10s.; bars, £4 12s. 6d. to £4 15s. In these there is, it is apparent, an upward tendency. Siemens, best, £5 to £5 2s. 6d.

The tin-plate trade is gaining vigour, and exports are steadily on the increase. Last week the total export from Swansea was 71,941 boxes, and receipts from works 77,277 boxes. Stocks now held amount to 144,539 boxes. It was reported on 'Change that a number of works are at a standstill, which may give a better tone to the going ones. But it is evident that a better condition is coming about, and makers must, of necessity, with the advance in raw materials, get better prices. The cash quotations are: Steel cokes, 12s. 3d. to 12s. 6d.; Siemens, 12s. 6d. to 12s. 9d.; ternes, 22s. to 26s.; best charcoal, 13s. 6d. to 13s. 9d.; block tin is at £100 to £101; patent fuel is moderately brisk. Swansea price, 10s. 9d. to 11s.; pitwood, 17s. to 17s. 3d. At Cardiff pitwood is 14s. 6d. to 14s. 9d.; iron ore, 10s. 9d. to 11s.

The Cardiff building strike continues, and is now extending to the plasterers, who demand 8½d. an hour.

On Monday the shaft of the winding engine broke at Tylarstown Colliery, and for a time 1000 men are idle. There were 500 men at work at the time, and these were released in hoists by the upcast.

The largest consignment of wire ropes from Cardiff left the Elliot Wire Works this week. It amounted to twenty coils of 80 tons each.

A representative party of Belgian engineers visited Cardiff this week, and inspected the Great Western Collieries, Pontypridd, the Llwyypia, Dowlais Cardiff Colliery, and Cyfarthfa Steel Works. There were accompanied by members of the South Wales Institute of Mining Engineers, who held their meeting this week.

I hear that Mr. Williams, of David, Williams, and David, of Cardiff, has been appointed chief surveyor of the Great Western Railway Company at a salary of £800. The Taff Vale Railway continues to show an increased revenue, and stock is improving.

The Ebbw Vale Company is going to issue £200,000 5 per cent. debentures.

The Cardiff Corporation intend to create new stock not exceeding £422,500. Their great enterprise, the waterworks at the Beacons, are progressing well.

The Town of Cowbridge is beginning to move in getting increased water supplies.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE firmness of tone, which has been the principal characteristic of the iron trade over here for several weeks past, has not in any way been interrupted during the week, but it has made no more further progress towards practical results, that is, advanced prices. For the present, a general stiffening of prices is all that can conscientiously be reported, not, however, excluding some special and successful cases of rising quotations. The general belief seems to be, that a healthy revival of trade can only set in gradually and with cautious steps.

The Silesian iron industry has remained in a weak state, generally speaking. An advance in prices is not to be thought of for the present. The pig iron trade, especially, is badly off, in consequence of the extremely limited business done on foreign account. Manufactured iron is in comparatively fair request, especially as regards bars and girders. Prices, of course, are depressed here as well as in all other branches, and for large lots concessions are still made up to 20 p.c. Present basis price for bars is M. 132·50 p.t. at works.

Regarding the situation of the Austro-Hungarian iron market, it may well be termed a satisfactory one for this time of the year. For pig iron, especially Hungarian brands, a pretty healthy demand has been experienced during the week. In the finished iron department girders have been only very moderately inquired for in Vienna, while in the country rather more business has been done in that article. For the heavier sorts of plates also a fair request is coming forward; the same holds for wire. Tools have slightly improved in demand lately, while the state of the prices remains depressed as before.

In France the business doing on the iron market continues to be of a limited description. The blast furnace works especially are hard up for orders; while the bar, as well as the plate mills, have been fairly well employed up to date. Bars No. II. are noted 155f. p.t. Iron plates 185f. p.t. at works.

The state of the Belgian iron trade has in no wise altered since last week. The convention prices are likely to be modified, as the construction shops complain of being unable to compete with English or German works at the present Syndicate quotations. Luxemburg foundry pig No. 5 is quoted 48f. p.t.; forge pig, 44f.; bars, No. 1, for inland, 120f.; sheets, 170f. p.t.

The somewhat firmer tone of previous weeks has been fairly well maintained on the Rhenish-Westphalian market, without, however, developing into actual briskness. As regards the Siegerland and Nassau iron ore trade, a decidedly improving tone may be noticed for spathose iron ore. In Luxemburg-Lorraine, on the other hand, a moderate business is doing in minette, and prices have slightly decreased of late. Pig iron has been reported in a somewhat livelier request on the whole, and prices have begun to show a tendency to firmness. Hopes are entertained that the autumn business will turn out a fairly good one. Orders known up to date are reaching into August. Forge pig is pretty well inquired for. Spiegeleisen remains unchanged in price as well as in demand. The same may be told of the other qualities. On the malleable iron market an unmistakeable improvement has been experienced with regard to demand, and prices, unfortunately, are not in the least inclined to move in an upward direction. The employment of the works must still be regarded as irregular. Bars and girders are brisk of sale, but at unremunerative prices. The condition of the hoop trade continues to be satisfactory. Plates are well inquired for on the whole. The same may be said of sheets. Foundries and machine factories are reported in irregular employment. The tube mills are briskly occupied for a considerable time to come, inland demand being very good, while from abroad but few orders are coming in. Prices are firm, M. 120 p.t. being quoted per ton, Rhenish-Westphalian tube mills.

The total production of pig iron in Germany, including Luxemburg, was, for the month of May, 1892, 408,896 t., of which 165,706 t. were forge pig and spiegeleisen, 27,213 t. Bessemer, 168,080 t. basic, and 47,897 t. foundry pig. In May, 1891, production amounted to 354,010 t.; in April, 1892, it was 396,821 t. From January 1st to May 31st, 1892, 2,006,436 t. were produced, against 1,758,393 t. for the same period the year before.

The General Assembly of the Gothard Line Company has declared that a 6 per cent. dividend will be paid to the shareholders this year.

Hamburg is about to establish a grand central station hall, the plans, specifications, &c., for which are said to be under technical examination. Bremen will not remain behind, the Municipality having granted 16,000,000 marks to be devoted to the extension of the harbour works at Bremerhaven. Rumours are current that at Bremerhaven a tank for American petroleum will be established, besides the tank for Russian petroleum, which already exists in that place.

The Russian Ministry of Communication is trying to have all the higher railway official posts in the kingdom of Poland occupied by native Russians, while the employés of foreign—*i.e.*, Polish nationality—are placed in the interior of Russia.

Respecting the Przibram catastrophe, no further reliable information has as yet been published; but great care is taken by the authorities to have the matter thoroughly investigated.

Within the hundred years the number of miners employed has thus multiplied one hundred-fold, the quantity of production has increased two hundred-fold, while the value of production has augmented by 457 per cent.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 26th.

REPORTS from industrial centres throughout the United States show a slight improvement in general business. Buyers for months past have been purchasing with much care, and the result is that with improving demand, there are no stocks on hand. Railroad traffic is quite heavy, and expenditures by railroad companies are now increasing. Clearing House returns show an increase for the past week over last year of 12 per cent. The net earnings of railroads during April were about the same as April last year. The gross earnings were about 5½ per cent. greater. The exportable wheat crop this year will be 220,000,000 bushels, about the same as last year. The heavy export movement in gold is exciting attention.

NEW COMPANIES.

THE following companies have just been registered:—

Twelve Hours Stove Syndicate, Limited.

This company was registered to acquire certain patents relating to stoves, and to develope and work the same. For the purposes of registration the company is declared to consist of 100 members, with an individual liability in the event of the winding up of the company of £1.

Inventors' Exploitation and Development Company, Limited.

This company was registered with a capital of £5000, in £1 shares, to carry into effect an agreement, made 10th June, between A. Payne of the one part, and F. Boultbee, on behalf of this company, of the other part, for the acquisition of certain patents and inventions, and to develope and work the same.

The number of directors is not to be less than three nor more than seven. Qualification, holding shares. Remuneration, £25 per annum each.

Electrical Coal-cutting Contract Corporation, Limited.

This company was registered with a capital of £402,000, divided into 60,000 £5 ordinary shares, 20,000 £5 deferred shares, and 2000 £1 founders' shares, to adopt and carry into effect an agreement expressed to be made between the Woodfield Syndicate, Limited, of the one part, and this company of the other part, for the acquisition of certain patents, particulars of which are given in the said agreement; and generally to carry on, in all their respective branches, the businesses of colliery proprietors, coke manufacturers, coal cutters, contractors, electricians, electrical engineers, mechanical engineers, producers and suppliers of electricity, &c. The first subscribers are:—

	Shares.
Sir A. C. Campbell, M.P., Blythswood, Renfrew	105
L. Wood, J.P., Hermitage, Chester-le-Street, Durham..	105
Hon. G. W. Winn, Nostell Priory, Wakefield ..	105
J. R. Knowles, Westwood, Ince, near Wigan ..	105
S. Rivington, Kilmeney, Wimbledon, Surrey ..	105
W. T. Goolden, 28, Westbourne Park	105
F. Stobart, J.P., Biddick Hall, Fencehouses, Durham..	105

Each of the above signatories holds 100 ordinary and five founders' shares.

The number of directors shall not be less than five nor more than ten; the first to be elected by the signatories to the memorandum of association. Qualification, 5 founders' and 100 ordinary shares. Remuneration not specified.

Triple Oil and Composition Company, Limited.

This company was registered with a capital of £15,000 in £1 shares, to acquire the undertaking of the Triple Oil and Composition Company, now carried on at Belvedere, Kent; generally to carry on business as manufacturers of and dealers in composition for ships' bottoms, oils, and every description of paints, enamels, and varnishes.

The number of directors is not to be less than three nor more than seven. The first to be elected by the signatories to the memorandum of association. Qualification, 100 shares. Remuneration to be determined in general meeting.

Alston and Nentforce Limestone Quarry Company, Limited.

This company was registered with a capital of £2000 in £100 shares, to acquire certain limestone quarries near Alston station, Cumberland, and to develope and work the same.

The number of directors shall not be less than three; the first are: J. Polglase, C. W. Harrison—managing directors—and W. C. Reid; qualification not specified; remuneration, £400 per annum.

PROMOTION IN THE DOCKYARDS.—An Admiralty memorandum was received in Portsmouth on Wednesday, setting forth that, in order to further encourage artisans, skilled and ordinary labourers, and others borne upon the establishment to special exertions, it shall be competent for the superintendents at the several dockyards in the month of November to promote men from a lower to a higher rate of pay in their respective classes, as a reward for special skill, industry, and attention to duty. The numbers to be so promoted will be in addition to the vacancies for advancement created by ordinary wastage from deaths, superannuations, and discharges. The officers, in making recommendations, are to give especial consideration to the cases of men established prior to April, 1891. With regard to the general question of advancing men from a lower to a higher rate in their class, the Admiralty are anxious to impress on the superior officers the necessity for the closest possible scrutiny in dealing with this matter, in order to secure justice being done to the men as a whole.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

14th June, 1892.

11,183. FOOTBALL and CRICKET BOOTS, G. Maynard, London.
11,184. REFRIGERATING APPARATUS, J. Price and M. C. Bannister, London.
11,185. MACHINES for DIGGING POTATOES, J. E. Ransome and J. A. Lewis, London.
11,186. FASTENING DEVICE for STAIR RODS, J. W. Pape and J. Wilson, London.
11,187. REMOVING from AIR MATTERS SUSPENDED THEREIN, T. Parkinson and G. M. Parkinson, London.
11,188. CLOTHES-WASHING MACHINE, W. Le Fevre, London.
11,189. FASTENER or CLIP, W. H. Parkes, London.
11,190. VERTICAL BAND SAW MACHINE, B. Wild and R. Wild, London.
11,191. LAUNDRY APPARATUS, J. G. Lorrain, London.
11,192. DRIVING of DYNAMO-ELECTRIC MACHINES, T. Reid, London.
11,193. WATER-CLOSETS, P. Bright, London.

15th June, 1892.

11,194. INDICATING APPARATUS for HIGH TENSION CIRCUITS, B. M. Drake and J. M. Gorham, London.
11,195. PORTABLE or FOLDING TABLES, G. H. Ellis, Middlesex.
11,196. UMBRELLA FRAME, M. Hartung and A. Adam, London.
11,197. VALANCE RODS for BEDSTEADS, &c., C. Day, London.
11,198. TRAPS for CATCHING RABBITS, T. Roberts, Wednesfield.
11,199. PERFECT SAFETY SCARF SLIDE, J. Machin, Birmingham.
11,200. INDIA-RUBBER TIRES of WHEELS, J. Stephenson, London.
11,201. NET ADJUSTER for LAWN TENNIS, R. C. Hope and F. H. Walker, Scarborough.
11,202. MECHANICAL HAY-MAKER and GATHERER, T. Hill, Hull.
11,203. CONCENTRATING SULPHURIC ACID, J. Graham, Manchester.
11,204. JEWELLERY, M. Davis, Birmingham.
11,205. CIRCULAR KNITTING MACHINES, W. I. James, Stafford.
11,206. FLY-PAPERS, J. Ellis, Hull.
11,207. FRAMES for SHIPS' DOORS, W. Turner, Belfast.
11,208. AIR PUMPS for DIVING APPARATUS, A. E. Stowe, London.
11,209. CUTTING OPEN ENVELOPES, J. A. Paice, Ashwood Bank.
11,210. SEALING CANS, R. A. Sloan and J. E. L. Barnes, London.
11,211. HEATING OVENS, R. A. Gilson and W. J. Boocr, London.
11,212. FACIA, W. James, London.
11,213. BICYCLES, TRICYCLES, &c., J. E. Clarke, Manchester.
11,214. STANDARD for SCHOOL SEATS, A. E. Leete, South Shields.
11,215. WINDOW SASH FASTENER, F. B. Shuffrey, Birmingham.
11,216. HANDLE FASTENING, W. H. Phillips and W. J. Cross, Birmingham.
11,217. FURNACE and other such BARS, S. Baugh, Birmingham.
11,218. STOPS for COAL VASE FURNITURE, F. W. Green, Birmingham.
11,219. WHEEL, J. Abraham, Northampton.
11,220. CYCLES, L. Melliet.—(*E. Boule, France.*)
11,221. BOOK COVERS, H. E. Cohen, Glasgow.
11,222. TREATING CHLORIDE of MAGNESIUM, J. J. Lish, Newcastle-on-Tyne.
11,223. MOUNTING FISHING TACKLE, W. M. James, Redditch.
11,224. CLIPS for CYCLISTS' TROUSERS, H. Harford, South Shields.
11,225. MAKING LAMP BURNERS, F. R. Baker, Birmingham.
11,226. CEMENT for BOILERS and FLUES, G. C. Taylor, Helsby.
11,227. SCREW NAIL, S. Brame and G. Hacket, Shrewsbury.
11,228. KEY-SEAT CUTTING APPARATUS, J. Barbour, Halifax.
11,229. DIAL INDICATING STEEL-YARDS, H. J. Avery and A. W. Brown, Birmingham.
11,230. DRILL SHAPING and SHARPENING MACHINE, G. A. Goodwin.—(*Messrs. A. and —. Smith and D. B. Schiutema, South Africa.*)
11,231. PISTON ROD PACKINGS, J. Butterworth, Pendleton.
11,232. COIN-FREED MACHINE, J. and H. C. Scoles, Huddersfield.
11,233. PREVENTING WINDOWS VIBRATING, C. H. Maxsted and A. Bell, London.
11,234. CEMENT GRINDING MACHINES, W. W. Hewitt, Greenhithe.
11,235. CASE and TEA FLASK COMBINED, R. Kean, Drongan.
11,236. SCARF PIN HOLDER, J. R. and J. W. Green, London.
11,237. REGULATING SUPPLY of WATER, G. S. Duncan, London.
11,238. AERIAL LOCOMOTION, F. Walton, London.
11,239. LININGS for RUBBING SURFACES, K. W. Hedges, London.
11,240. PNEUMATIC TIRES, J. Rémy and M. Rémy, London.
11,241. LAYING CONCRETE FLOORS, W. Lancaster, London.
11,242. REELS for SEWING COTTONS, J. Wedderburn, London.
11,243. AUTOMATICALLY MOVING COAL, W. Keenan, London.
11,244. DEVICE for COVERING BUTTONS, W. Adams, London.
11,245. MACHINERY CLUTCH CONNECTION, H. Bunker, London.
11,246. APPLYING BLUE for WASHING PURPOSES, W. I. Taylor, London.
11,247. MAKING a NEW KIND of FABRIC, R. Balsa, London.
11,248. MOPS, E. F. Boucheré, London.
11,249. MIXING and DISSOLVING LIQUIDS, O. Hamilton, London.
11,250. REFRIGERATING APPARATUS, H. E. Newton.—(*W. Alsop and W. Blackall, New South Wales.*)
11,251. PNEUMATIC TIRES for VELOCIPEDES, W. Edwards, London.
11,252. WHEELS for PERAMBULATORS, &c., J. Dame, London.
11,253. PHOTOGRAPHIC PLATES, J. B. B. Wellington, London.
11,254. SENSITISED FILMS for CARBON PRINTING, J. T. Clarke, London.
11,255. GRASS-CUTTING MACHINES, A. B. Wallace, London.
11,256. PRINTING MACHINES, A. Gray, London.
11,257. CRUCIBLES, C. King and J. M. Stuart, London.
11,258. TIE FASTENER, A. Lachenal, London.
11,259. VALVES, E. A. Bolinder, London.
11,260. DEVICES for CONVERTING MOTION, M. C. Wilson, London.
11,261. PILED FABRIC, &., A. Morton and J. Morton, London.
11,262. FASTENING for BUNDLES, &c., J. S. Fairfax.—(*T. B. Kisch, South Africa.*)
11,263. FARE-COLLECTING BOXES, J. S. Fairfax.—(*T. B. Kisch, South Africa.*)
11,264. UNBARKING WOOD, P. Jensen.—(*C. Bache-Wiig and E. Morterud, Norway.*)
11,265. UNBARKING WOOD, P. Jensen.—(*C. Bache-Wiig and E. Morterud, Norway.*)
11,266. BRICK PRESSING MACHINE, C. W. Raymond, London.
11,267. PHOTOGRAPHIC DEVELOPMENT DISH, H. Rayner, London.
11,268. RAZORS, C. Berks, London.
11,269. CLOTHING for UNHEALTHY FEET, H. Albert, London.
11,270. BROOCHES, W. Matthews, Birmingham.
11,271. TEA and COFFEE POTS, JUGS, &c., T. K. Firmin, London.
11,272. FIRE ESCAPE, P. Zahringer and H. Bucksey, London.
11,273. ATMOSPHERIC GAS BURNER, F. Whittingham, Birmingham.
11,274. FILTERS, A. M. Clark.—(*J. E. Sandelin and O. A. Sjostrom, United States.*)
11,275. DISINFECTING, &c., COMPOUND, J. M. Raymond, London.
11,276. LENSES, H. V. Weyde, London.

16th June, 1892.

11,277. ELECTRIC METERS, G. A. Goodwin and H. Foster, London.
11,278. HOT WATER APPARATUS, H. Sutcliffe, Halifax.
11,279. STEAM PURIFIER, R. G. Brooke, Salford.
11,280. MACHINES for SPINNING FIBRES, A. W. Metcalfe, Halifax.
11,281. CYCLE OUTFIT BAG, J. Willmott, jun., Birmingham.
11,282. SIGNALLING on RAILWAYS, T. Barrow, Liverpool.
11,283. RAILWAY ROOF LAMPS, W. McLaren and B. A. Collins, London.
11,284. ADJUSTING SPRING BEDSTEADS, F. J. Stokes, Birmingham.
11,285. HANDLE SOCKETS for AGRICULTURAL PURPOSES, C. J. Shaw, Birmingham.
11,286. PUZZLE or GAME, R. N McMillan and J. Blair, Glasgow.
11,287. SOLITAIRES, W. Pearce, Birmingham.
11,288. SYSTEM of UPHOLSTERY, W. H. Richards, Nantwich.
11,289. ADVERTISING APPARATUS, H. Payton, Birmingham.
11,290. MANHOLES, J. Southall, Worcester.
11,291. AUTOMATIC SIGNALLING, W. E. Langdon, Derby.
11,292. SOLDERING BIT and SPIRIT LAMP, J. W. Webster, Exmouth.
11,293. CIRCULAR SAWING MACHINERY, B. Hausmann, Birmingham.
11,294. COIN-FREED LOCKS, J. M. Lockerbie and A. W. Wilkinson, Birmingham.
11,295. VENTILATION of COAL MINES, J. G. Allardice, Glasgow.
11,296. EVAPORATING LIQUIDS, W. J. Mirrlees and D. Ballingall, Glasgow.
11,297. RECOVERING TIN, J. P. Bayly.—(*J. J. Naef, United States.*)
11,298. WORKMAN'S CAN, M. H. Mason and T. Anderson, Newcastle-on-Tyne.
11,299. BOARDED FLOORS, O. Hetzer, Manchester.
11,300. BALLING TWINE, W. G. Bywater and T. B. Beanland, Leeds.
11,301. REST for CYCLES, C. H. Milburn, London.
11,302. MEASURING INSTRUMENTS, F. H. and H. Nalder, C. W. S. Crawley, and A. Soames, London.
11,303. WHEELS for VELOCIPEDES, E. de Pass.—(*C. Delarue, France.*)
11,304. BOTTLES, J. Lane, Smethwick.
11,305. SECURE DOUBLE LEVER LOCK, W. S. Ross, Dublin.
11,306. WHEELBARROWS for CARBOYS, R. Clarke, Manchester.
11,307. OVEREDGE SEWING MACHINES, W. H. Blakeney, Glasgow.
11,308. SHAPING MEAT, F. James, Longton.
11,309. VARIABLE SPEED GEARING, R. S. Wood, Manchester.
11,310. FRICTION BRAKE, G. Watts and R. Hauxwell, Boyne.
11,311. FENDERS for SHIPS, T. James, Liverpool.
11,312. PARLOUR GAME, W. R. Rumfitt, York.
11,313. CRANES and WINCHES, W. James and J. Jones, Chester.
11,314. STOVE, A. M. Lanner, London.
11,315. STEAM GENERATORS, J. M. Stratton, London.
11,316. ELECTRIC ALARUMS, G. W. van Vianen, London.
11,317. PUMPS, W. Fraser and J. G. Chapman, Birmingham.
11,318. SKEIN-DYEING, A. S. Lyon and J. H. Lorimer, London.
11,319. HORSESHOES, H. Biles, London.
11,320. TELEPHONIC APPARATUS, C. Vogt, London.
11,321. TRANSPORTING YOUNG PHEASANTS, C. W. Hopkins, Londons.
11,322. COUPLING LINK, O. Imray.—(*A. H. Harper, Cape Town.*)
11,323. SOLES for SANDALS, O. Imray.—(*Société A. Ravinet, E. Gryesz and Cie.*)
11,324. ARTIST' STOOL and BOX, F. W. Loring, London.
11,325. PROPELLER for FLOATING VESSELS, C. F. Osborne, London.
11,326. TUBES for AERATION, &c., R. H. Courtenay, London.
11,327. FIRE EXTINGUISHING APPARATUS, A. J. Boult.—(*M. V. Cranen, Belgium.*)
11,328. CIRCULAR KNITTING MACHINES, G. Blackburn and A. B. Spring, London.
11,329. MECHANISM for CLOSING the ENDS of GUNS, E. W. Lloyd and D. S. Marjoribanks, London.
11,330. PNEUMATIC TIRE INFLATORS, E. H. Hill, Sheffield.
11,331. MAKING SEAMLESS TUBES, W. Ambler, H. Branter, and W. J. Warren, Leeds.
11,332. SECURING the RIMS of WHEELS, W. H. Dunkley, London.
11,333. FOOT DRESS, T. Harriot, London.
11,334. EMBOSSING MACHINES, J. Y. Johnson.—(*T. C. Orndorff, United States.*)
11,335. TUBE CLEANERS, P. Lechler and C. Münzenmaier, London.
11,336. SIGNBOARDS for ADVERTISEMENTS, C. Jones, London.
11,337. WHITE LEAD, R. W. E. MacIvor and W. Smith, London.
11,338. SOAKING BOTTLES, T. E. Hartland, Bristol.
11,339. RUBBER TIPS for BOOT, &c., HEELS, W. H. Fox, Bristol.

17th June, 1892.

11,340. STEM GUIDES of STAMP BATTERIES, C. Raleigh, London.
11,341. MANURE, B. E. R. and J. E. R. Newlands, London.
11,342. PUMPING APPARATUS, T. Dhunjeebhoy, Manchester.
11,343. SLEEVE LINKS, C. H. Collins, Birmingham.
11,344. CASING for CABLES and WIRES, F. B. Nicholson, London.
11,345. DISTRIBUTING INSECT POWDER, W. F. Charles, Woodley, near Stockport.
11,346. LUBRICATORS, A. Conner, Glasgow.
11,347. MANUFACTURE of SPIRAL SPRINGS, N. B. Roberts, Sheffield.
11,348. STOPPERING FLASKS, BOTTLES, &c., W. Slater, London.
11,349. JACQUARD CARD PUNCHING MACHINE, V. Lacasse, Manchester.
11,350. SECURING BATTENS of HATCHES, M. Hutchinson, Saltcoats.
11,351. DRAWING and WRITING APPLIANCE, R. S. Burn, Aberdour.
11,352. STOPPING STEAM ENGINES, W. R. and R. Atkinson and T. Wilson, Bradford.
11,353. ELECTRICAL ALARUM CLOCKS, D. J. Mullarky, Bradford.
11,354. CYCLES, M. J. Schulte and S. Bettmann, Leicester.
11,355. WOOLLEN DRY FELTS, T. R. Hardman, Manchester.
11,356. SCARPHING METAL PLATES, P. Harvey, Stockton-on-Tees.
11,357. DECORATIVE WALL-PAPERS, &c., P. Klinka, Glasgow.
11,358. SAFETY RAILWAY COUPLING, H. Almond Guildford.
11,359. "WASTE" for CLEANING MACHINERY, F. Law, Manchester.
11,360. SELF-LOCKING WINDOW-SASHES, H. Ball, Manchester.
11,361. DRAIN-TESTING APPARATUS, S. H. Adams, London.
11,362. TOYS, R. Wallwork, Manchester.
11,363. SPRINGS for CYCLE SADDLES, J. Mountfort, Coventry.
11,364. CRICKET BAT HANDLES, C. Rose, jun., Manchester.
11,365. MILLS for SPINNING COTTON, T. Sington, Manchester.
11,366. COMPOSITION for BLEACHING LINEN, J. Kennedy, Halifax.
11,367. AUTOMATICALLY REGULATING WARPS, R. Wilby, Huddersfield.
11,368. SEPARATORS, C. Clough, Halifax.
11,369. MATURING WHEAT, T. N. and A. M. Robinson and R. Baxter, Liverpool.
11,370. SEPARATORS, C. Clough, Halifax.
11,371. PROPELLING BOATS, G. W. Mallet, Brighton.
11,372. NUT-LOCKS, R. F. Drury, Sheffield.
11,373. BAKERS' OVENS, J. V. and H. E. Thompson and H. Seeley, Liverpool.
11,374. MEASURING DISTANCES, A. H. Kuhn, London.
11,375. LETTER CARD, F. M. Merridew, London.
11,376. VALVES and COCKS, A. Pullan and W. Spence, Surbiton.
11,377. GAME APPARATUS, J. A. Eno, London.
11,378. CHILDREN'S COTS, G. W. Moon, London.
11,379. HAND PHOTOGRAPHIC CAMERAS, A. P. Riley, London.
11,380. BALLS for PRACTISING GAMES, A. G. Ellis, London.
11,381. FLUSHING CISTERNS, T. W. Rogers, London.
11,382. MANUFACTURING COMPOUND, &c., BODIES, H. Niewerth, London.
11,383. LACE HOOK for TYING UP SHOES, J. A. Stock, Germany.
11,384. ROADWAYS, A. B. Cochrane and H. B. Sheridan, London.
11,385. PAPER-MAKING MACHINES, R. W. Moncrieff London.
11,386. FILTERS, J. G. Lorrain, London.
11,387. FILTERING LIQUIDS, A. Dubosc and E. Hermite, London.
11,388. HOLDER for SUSPENDING TIES, R. J. Steward, London.
11,389. APPARATUS for TEACHING PEOPLE to SWIM, E. B. Gaze, London.
11,390. BALLOONS, H. Poliakoff, London.
11,391. APPLIANCE for HUNTERS, &c., H. Poliakoff, London.
11,392. PIANO STOOLS, J. J. Hering and J. J. Hohmann, London.
11,393. ELECTAIC RAILWAYS, F. Wynne, London.
11,394. SIGNALLING on RAILWAYS during FOG, T. Hubbard, London.
11,395. AZO COLOURS, B. Willcox.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
11,396. PLUNGER, J. P. Jones, London.
11,397. ATTACHMENT to TRAVELLING BAGS, J. F. K. Simpson, London.
11,398. POSTAL WRAPPER, J. E. Browne, London.
11,399. PRODUCING DRY SUPERHEATED VAPOURS, W. Schmidt, London.
11,400. REPAIR of PNEUMATIC TIRES, M. E. Tarver and J. P. A. Bowley, London.
11,401. METAL BOXES, G. T. Peppé, London.
11,402. HOLLOW ROLLERS, E. G. Hoffmann, London.
11,403. ELECTRIC MOTORS, W. T. Goolden and L. B. Atkinson, London.

18th June, 1892.

11,404. ADVERTISING, J. Diaz, London.
11,405. PACKING CLOTH, W. B. Maxfield.—(*M. Von Gross, Germany.*)
11,406. STRETCHING FABRICS, J. Westley and M. J Pilling, Manchester.
11,407. ENAMELLED BRICKS and TILES, C. F. Hall, Manchester.
11,408. PREVENTING MARINE ENGINES RACING, W. Burns, Glasgow.
11,409. MOULDING WHEELS, A. B. Brown and R. C. Smith, Glasgow.
11,410. DOOR for LIFTS, J. A. L. Campbell and C. P. Cameron, Edinburgh.
11,411. ERECTING BUILDINGS, J. Dougan, J. McMillan, and J. L. Crawford, Glasgow.
11,412. GATE for HOISTS, J. A. L. Campbell and C. P. Cameron, Edinburgh.
11,413. ANTI-PIRATING CORKAGE, J. Wilkie.—(*W. H. Furlonge and A. B. Stirling, South Africa.*)
11,414. HORSE-HOE, T. C. Sargeant, Northampton.
11,415. OIL and GAS STOVES, E. Harvey, Newcastle-upon-Tyne.
11,416. COLOURING FABRICS, F. G. Grafton and W Browning, Manchester.
11,417. CLOTHS, F. L. Steel, Manchester.
11,418. MOUSE or RAT-TRAP, S. Hern and W. Kingdon, London.
11,419. MAKING FOOD for HORSES, T. Price, Bishopston, near Swansea.
11,420. WALL HOOK, &c., for PICTURES, G. Y. Iliffe, Birmingham.
11,421. INDICATING PRESSURE of GAS, H. P. Smith, London.
11,422. MACHINE for CUTTING TURNIPS, E. Keighley, Scarborough.
11,423. PNEUMATIC WHEEL TIRES, C. Jenatzy, London.
11,424. TELEPHONE EXCHANGES, G. C. Dymond.—(*A. B. Strowger, United States.*)
11,425. PNEUMATIC TIRES for VEHICLES, W. Stelfox, Manchester.
11,426. INDICATING SWITCHES, G. C. Dymond.—(*A. B. and W. S. Strowger, United States.*)
11,427. VARIABLE ROPE, G. H. Gwyn, Liverpool.
11,428. COUNTING APPARATUS, E. Paproth and R. Aster Liverpool.
11,429. MANUFACTURE of AERATED WATERS, J. G. Lorrain, London.
11,430. RAILWAY SIGNALLING APPARATUS, T. Partridge London.
11,431. REVERSIBLE CARPETS, Henderson and Co., Ld., and R. Britton, London.
11,432. LUBRICATING STEAM ENGINES, A. C. Pain, London.
11,433. BOOK POST COVER or ENVELOPE, G. S. Hadfield, Derby.
11,434. OPTOMETERS, R. W. Row, Birmingham.
11,435. COCKS, J. T. Hailwood, Rochdale.
11,436. CARVING FORK GUARDS, J. Haywood and Co., and W. Seedhouse, Sheffield.
11,437. CARRIAGE SLIDING SEATS, J. W. Clift, Wellington.
11,438. PNEUMATIC BATH, T. H. Rees, London.
11,439. CASES and TRAYS, A. Borqzimmer.—(*F. Ulrich, Germany.*)
11,440. MINERS' SAFETY LAMPS, T. Morris, Birmingham.
11,441. SELF-ACTING SPINNING MULES, J. Moorhouse, Manchester.
11,442. PACKING, J. Lewis, London.
11,443. DEVICE for PROTECTING the EYES, T. Coventry, London.
11,444. LOCK NUT DEVICE, E. Löhnert, London.
11,445. TURNING HOLLOW-WARE, J. Millington and W. J. Jones, London.
11,446. MAKING SMOOTHING IRONS, J. Millington, London.
11,447. FIRE-GRATES, H. H. Wood, London.
11,448. ENGINE, G. Poscher, London.

11,449. PROPELLING AERIAL VESSELS, A. Vogelsang, London.
11,450 SECURING TIRES to WHEELS, J. J. Bertrand, London.
11,451 LETTER or PRINTERS' TYPES, E. Hünsch, London.
11,452. FACILITATING SKETCHING of DESIGNS, W. Stranders, London.
11,453. PACKING CASE for WINES, &c., W. E. Hanson, London.
11,454. PAPER KNIFE, W. M. Taylor, London.
11,455. TOYS for CHILDREN'S PLAY, W. S. Simpson, London.
11,456. CASES for LAUNDRY BLUE, J. O. Egestorff, London.
11,457. CIGAR CLIP ATTACHMENT, A. S. Cartwright, Birmingham.
11,458. SECURING PNEUMATIC TIRES, R. Green, Birmingham.
11,459. AIR COMPRESSORS, R. Schram, London.
11,460. INFLATABLE HARNESS PADDING, J. B. Haines, jun., London.

20th June, 1892.

11,461. SOCKETS for PICK SHAFTS, W. H. M. Neave, Sheffield.
11,462. MANUFACTURE of SEWAGE SLUDGE into BRICKS, H Lockwood, Manchester.
11,463. FASTENERS for BELTS and STRAPS, A. Timpo, Manchester.
11,464. THE CHLOROXOGEN INHALER, T. G. H. Nicholson, Liverpool.
11,465 FIRE-LIGHTERS, W. D. A. Bost and T. F. Haldane, Glasgow.
11,466. TUBES for BOILERS. R. W. Boyd.—(*J. W. Boyd, China.*)
11,467. NECKTIES, A. Bertin, Manchester.
11,468. BATH CHAIR, J. Higham, Manchester.
11,469. COIN-OPERATED DEVICE, S. and T. Glover, and J. Critchley, St. Helens.
11,470. BEVERAGE, E. T. and W. V. Brett, London.
11,471. SYSTEM of RAILWAY SIGNALLING, C. Brown, London.
11,472. SEWING MACHINES, J. H. Ashworth and J. McCormick, Manchester.
11,473. ARTIFICIAL PALATES, J. A. A. Schoondermark, London.
11,474. BATHS, S. H. Adams, London.
11,475. MAKING PORTABLE BATHS, J. H. and G. Curle, London.
11,476. PHONAUTOGRAPHS, C. A. Randall, London.
11,477. PNEUMATIC TIRES for CYCLES, R. Waycott, Paignton.
11,478. SIPHON-STARTING APPLIANCE, T. Thorp, Whitefield.
11,479. DYERS' VATS, J. Grime, Glasgow.
11,480. SUSPENDER for PAINT-POTS, W. Williams and W. E. Lewis, Bristol.
11,481. BREWING, D. H. Croll, Shipston-on-Stour.
11,482 PEEP-HOLE UMBRELLA COVERS, T. Rosethorn, Manchester.
11,483. TRAVELLING BAGS, A. Timpo, Manchester.
11,484. TENTINGS and TARPAULINS, &c., G. E. Stevens, Manchester.
11,485. ADVERTISING, J. C. Webb, London.
11,486. OIL-LAMPS, A. H. Griffiths and Evered and Co., Birmingham.
11,487. TELEPHONES, R. F. Jeffries, London.
11,488. BOOT PATTERN GRADER, H. W. Morris, Northampton.
11,489. MAKING FILTERING PLATES, L. A. Enzinger, London.
11,490. BOLTS for DOORS, W. J. Steel and H. C. Braham, London.
11,491. ENAMELLED ADVERTISING PLATES, J. A. Jordan, Birmingham.
11,492. WOVEN WIRE MATTRESSES, &c., A. E. Wale, Birmingham.
11,493. BEDSTEADS, A. Phillips, Birmingham.
11,494. BICYCLES, J. Hodgkinson, London.
11,495. FILING and TIPPING BILLIARD CUES, J. Donnelly, London.
11,496. GARDEN TOOL, E. J. Taylor, London.
11,497. GRAPHIC INSTRUCTOR, W. Hackett and R. N. Coldwell, London.
11,498. STEAM PUMPS, J. Y. Johnson.—(*J. Belleville, France.*)
11,499. CYCLES, F. R. Bluemel, London.
11,500. BRAKES for TRAVELLING CRANES, J. Keeling, London.
11,501. LOCKING MONEY-BOXES, E. A. Jahncke and F. A. G. Gmelin, London.
11,502. PRODUCING COLOURING MATTERS, J. R. Geigy, London.
11,503. HIGH SPEED FLUID-PRESSURE ENGINES, C. H. Benton, London.
11,504. OBTAINING OXYGEN from AIR, L. Chapman, London.
11,505. CHANGING SUMS in BANKS, J. Jackson and A. J. Barnes, London.
11,506. DRESSING FABRICS, T. Thorp and C. Wood, London.
11,507. COMPOUND GEAR, T. Thorp and C. Wood, London.
11,508. DITCHING MACHINE, J. J. Wishard, London.
11,509. SHAFT-TUGS, J. Grammer, London.
11,510. HARNESS ATTACHMENT, T. S. Moodie, London.
11,511. CARVING WOOD, A. H. Tyler and J. S. E. de Vesian, London.
11,512. APPARATUS for GENERATING STEAM, T. Lishman, London.
11,513. SAFETY VALVES, R. C. Anderson, London.
11,514. INK BLOTTERS, M. Lindner, London.
11,515. SEAT, LEG REST, and CARD TABLE, G. N. Peake, London.
11,516. DOOR SPRING, H. Bunker and W. P. Chapman, London.
11,517. AUTOMATIC GUMMING MACHINES, E. Pott, London.
11,518. DRIVING BELTS and PULLEYS, G. Smith, London.
11,519. HAT BOX, F. T. Pillivant, London.
11,520. GAS CHANDELIERS, &c., C. Procopides, Manchester.
11 521. MAKING a SUBSTITUTE for WHALEBONE, L. Munk, London.
11,522. DIHYDROXYNAPTHALENE SULFIO ACIDS, B. Willcox.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
11 523. CUTTING CARDBOARD, W. W. and T. H. Lewis, London.
11,524. COIN-FREED APPARATUS, J. Jensen, London.
11,525. ELECTRIC CABLES, G. G. M. Hardingham.—(*Felten and Guilleaume Germany.*)
11,526. ELECTRIC CABLES, G. G. M. Hardingham.—(*Felten and Guilleaume, Germany*)
11,527. BALANCING FORWARD THRUST of PROPELLERS, T. Inglis, London.
11,528. DYNAMO-ELECTRIC MACHINES and MOTORS, J. A. C. Ziegler, W. R. Rutledge, and F. E. Allan, London.
11,529. PRINTING with AZO DYE-STUFFS, B. Wilcox.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
11,530. VELOCIPEDES, A. Taitte, London.
11,531. DRAWING COMPASSES, W. P. Thompson.—(*M. Ullmann, Germany*)
11,532. SECONDARY BATTERIES, W. A. Boese, Liverpool.
11,533. NEW COLOURING MATTERS, B. Willcox.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
11,534. HOBBE COLLARS, W. T. Fell, London.

21st June, 1892.

11,535. MILK RECEIVER, W. G. Woodcock.—(*E. Batters Canada.*)
11,536. FILLING, G. Downs and J. W. Dean, Huddersfield.
11,537. SAND SHIFTING MACHINE, J. P. Hall and T. Glover, London.
11,538. SIDE PLATE REDUCING VALVE, J. M. Nisbet, Newcastle-on-Tyne.
11,539. CLEANING DIRT from TUBE PLATES, J. B. Burrell, Cardiff.
11,540. MANUFACTURE of DOMESTIC ARTICLES, R. R. King, Wakefield.
11,541. VAN for CONVEYANCE, &c., of BREAD, W. Ramsey, Bishops Stortford.
11,542. BOTTLE STOPPERS, L. A. Eberhardt, London.
11,543. TWO-WHEEL VEHICLE BRAKE APPARATUS, J. H. Smith, jun., Bristol.
11,544. PRODUCING DESIGNS MECHANICALLY, M. Cobe, Brighton.
11,545. WICKETS for PRACTISING the GAME of CRICKET, W. G. Grace and T. Jenks, Bath.
11,546. RUBBER STAMP REGISTER ATTACHMENT, T. Brown, Bournemouth.
11,547. BRICK MAKING MACHINES, J. W. Mackenzie.—(*Muhlenbauanstalt Machinenfabrik and Eisengiesserei, Germany.*)
11,548. LUBRICATORS for DYNAMO-ELECTRIC MACHINES, C. S. Snell and Woodhouse and Rawson United, Ld., London.
11,549. SHIPS' RECORDING COMPASSES, W. E. Heys.—(*The Townsend Marine Invention Company, United States.*)
11,550. COMPOUND STEAM ENGINES, B. W. Burnet, Manchester.
11,551. SUSPENDER or BAG, A. W. and H. V. Down, London.
11,552. EXTRACTING GOLD from ORES, C. M. Pielsticker, London.
11,553. SMOOTHING PLATE GLASS, G. A. Marsh, jun., Manchester.
11,554. BOTTLE STOPPERS, G. F. Atwood, London.
11,555. WRENCHES, E. W. Rider, London.
11,556. TRAP, R. C. Meekren, London.
11,557. MAKING RETORTS from CLAY, W. S. Bancroft, Halifax.
11,558. MANUFACTURE of RETORTS, W. S. Bancroft, Halifax.
11,559. SENSITIVE INSIDE CALIBRE, A. Ritter, London.
11,560. VACUUM PUMPS, J. W. Fraser and J. D. Wilson, London.
11,561. MACHINERY for CLEANING BARLEY, T. Stevens, London.
11,562. UMBRELLAS, &c., C. Levey, London.
11,563. HAT PLANKING MACHINES, Christy and Co., D. Richardson, and W. E. Shore, Manchester.
11,564. GLOVES, F. R. Lange.—(*H. Gulden, Germany.*)
11,565. PNEUMATIC TIRES for WHEELS, A. I. Rath, Manchester.
11,566. LIGHT and FUEL PRODUCER, &c, L. Clement, London.
11,567. WIRE TOY PUZZLE, J. N. Greensill, Birmingham.
11,568. NECKTIES, E. C. Ogden, London.
11,569. TRANSLATING MOTIONS, W. E. Heys.—(*A. Kircher, Germany.*)
11,570. WILLOWING APPARATUS, W. and J. Hargreaves, Manchester.
11,571. COMBINED BLOTTER and RULER, S. G. Young, Manchester.
11,572. PUMP for USE in BARGES, &c., G. H. Culling, London.
11,573. FEED PUMPS, A. Blechynden, Barrow-in-Furness.
11,574. LITHOGRAPHIC MACHINE, C. S. Jones, Woodford Green.
11,575. HOLDER for FISHING RODS, W. P. Butchart, Dundee.
11,576. DISINFECTING APPARATUS, T. R. Duggan, Dublin.
11,577. TOBACCO PIPES, A. Gough, sen., London.
11,578. AERATING FERMENTING WORT, E. C. Polkinghorn, Plymouth.
11,579. LOOMS for WEAVING, R. C. Young and J. Masker, Barnsley.
11,580. HACKLING FLAX and other FIBRES, J. Erskine, Halifax.
11,581. REMOVING IMPURITIES from WOOL, W. E. Heys.—(*E. F. Dranez, H. P. J. Vassart, and J. H. S. M. Delattre, France.*)
11,582. VENT PEG, F. Harrison, Walsall.
11,583. WASH FAN, E. Wood, Rochdale.
11,584. SLOPSTONE, E. Wood, Rochdale.
11,585. SHOES, W. H. Stevens, Leicester.
11,586. WATER CIRCULATING DEVICES, P. Pinckney, Southsea.
11,587. BICYCLE DRIVING MECHANISM, F. H. Lloyd and C. Faulkner, Birmingham
11,588. FORCED DRAUGHT APPARATUS for FURNACES, J. Hill, London.
11,589. SUCTION AIR-BLAST GRAIN ELEVATOR, T. W. F. Knight, York.
11,590. TANKS for STORING PETROLEUM OIL, T. Mudd, Liverpool.
11,591. WEIGHING MACHINES, W. G. Herbert, Liverpool.
11,592. OPERATING AMMETERS, C. K. Mills.—(*H. M. Pilkington and R. S. White, United States.*)
11,593. DECORATIVE WALL VENTILATOR, E. Ballard, London.
11,594. VENTILATORS, A. J. Boult.—(*E. Hochheim.*)
11,595. FURNACE DAMPER REGULATORS, W. P. Thompson.—(*L. F. Smith, United States*)
11,596. MOTOR ENGINES, M. Mercier and F. Boddington, Manchester.
11,597. COLLARS, M. Friedly, London.
11,598. TRAMCARS and in MOTORS therefor, W. P. Thompson.—(*J. M. O'Kelly, United States.*)
11,599. HYDRAULIC PRESSURE REGULATORS, W. W. Sutcliffe, London.
11,600. HOLDING DEVICES, W. P. Thomson.—(*C. M. Conradson, United States.*)
11,601. CHECK VALVES, M. Laspeyre, London.
11,602. CONSTRUCTION of TOBACCO PIPES, A. H. Smith, London.
11,603. PLANING TOOLS, E. G. Brewer.—(*K. A. Windmüller, Germany.*)
11,604. MANUFACTURE of BEER, G. E. Jacquemin, London.
11,605. AIR CUSHIONS, G. W. Price, London.
11,606. MANUFACTURE of IRON and STEEL, F. Siemens, London.
11,607. WHALEBONE COMPOSITION SPRINGS, J. Baier, London.
11,608. PROJECTILES for AIR GUNS, E. J. D. Newitt, London.
11,609. FRAMING PHOTOGRAPHS, G. Haines, London.
11,610. VELOCIPEDES, H. Warrington, London.
11,611. HEATING ATTACHMENTS, A. C. Nunn, Chiselhurst.
11,612. SMOKE BURNING FIREPLACES, J. Dales, Leeds.
11,613. MANUFACTURE of BOOTS, &c, C. and E. Lewis, Northampton.
11,614. SWIMMING BELT. R. J. Lee, London.
11,615. HEATING FEED WATER, J. Y. Johnson.—(*J. Belleville, France*)
11,616. THREADING NEEDLES, Darling's Needle Threader Company.—(*C. F. Eckhardt, Germany.*)
11,617. DYNAMO MACHINES, C. J. Hall, London.

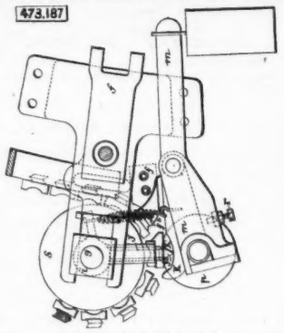
SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

473,187. MECHANISM FOR GRINDING THE TRAVELLING FLATS OF CARDING ENGINES, *B. A. Dobson and W. I. Bromiley, Bolton, England.*—*Filed November 13th*, 1891.

Claim.—(1) In a travelling flat carding engine, the combination, with the grinding roller supported in a counterbalanced lever, of the dummy or guide *k*, the slide or intermediate piece *j*, and the lever *i*, centred on the bowl shaft, substantially as herein set forth. (2) The combination, with the grinding roller and the guide surface *k'*, both supported and kept to their work by a weighted lever, of the slide or intermediate piece *j*, one portion of which is prepared to receive the working surface of the flat, and another is supported by the aforesaid guide surface *k'*, substantially as herein set forth. (3) The combination of the slide *j*, the bowl shaft *g*, bowl *s*, lever *i*, slide or intermediate piece *j*, with its prepared surfaces and finger j^2, as specified, dummy or guide *k*, with its prepared surface *k'*, the balanced lever *m*, snug *m'*, screw *r*,

473,187

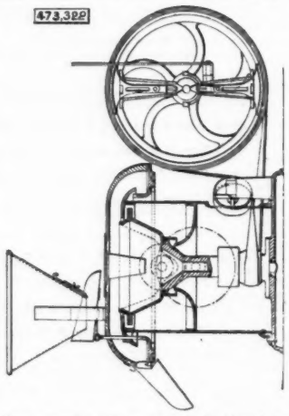


spring *p*, and incline j^2, all substantially as and for the purposes herein set forth.

473,322. CENTRIFUGAL MACHINE, *J. Laidlaw, Glasgow, Scotland.*—*Filed July 9th*, 1891.

Claim.—(1) The combination, with the revoluble foraminous receptacle or basket, of the chute adapted to receive the contents of a hopper and to discharge the same into the basket through suitable means, and the toothed ring adapted to be rotated and to vibrate said chute through suitable means, substantially as set forth. (2) The combination of the revoluble basket, the vibrating chute adapted to discharge into said basket, the rod attached to said chute, and the rotatable toothed ring engaging said rod for vibrating the chute, substantially as set forth. (3) The combination of the revoluble basket or foraminous receptacle, the rotatable toothed ring, the pivotted spring-pressed chute, and the rod having a lever connection with said chute and engaged by said toothed ring, substantially as set forth. (4) The combination of the casing or closure, the chambered cover having its

473,322

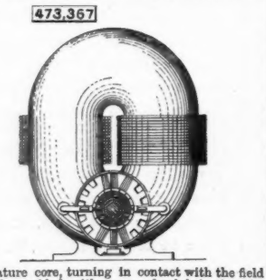


bottom secured to the upper end of said casing and provided with a discharge outlet and spout, the basket or foraminous receptacle having at its upper end an overhanging lip or rim and means for rotating it, the chamber within said casing or closure whose bottom curves upward centrally and stands at an interval from the support for said basket, the toothed plate or ring supported upon rolls or trucks hung in brackets secured to said casing, and means for rotating said ring or plate, the pivotted chute having connected to it the rod adapted to engage said toothed ring, the spring interposed between said cover and chute, and the hopper arranged above said chute, substantially as specified.

473,367. DYNAMO-ELECTRIC MACHINE, *S. H. Short, Cleveland, Ohio.*—*Filed June 24th*, 1891.

Claim.—(1) A dynamo electric machine having the armature turning in sliding contact with the field poles, substantially as set forth. (2) A dynamo electric machine having a laminated toothed armature core with iron outside the bobbins and insulated from

473,367

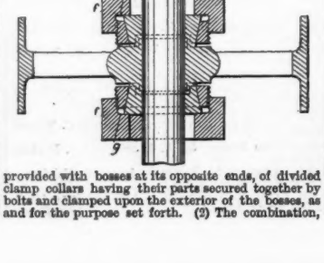


the armature core, turning in contact with the field poles and provided with means for lubricating the sliding contact thus made, substantially as described. (3) A dynamo-electric machine having the armature journalled at the periphery in bearings constituted by the field magnets and held by the magnetic attraction from endwise motion, substantially as described.

473,459. SPLIT PULLEY CLAMP, *J. J. Hogan, Brooklyn, N. Y.*—*Filed June 15th*, 1891.

Claim.—(1) The combination, with a split pulley hub

473,459

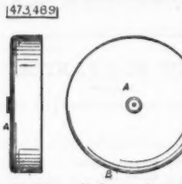


provided with bosses at its opposite ends, of divided clamp collars having their parts secured together by bolts and clamped upon the exterior of the bosses, as and for the purpose set forth. (2) The combination, with a pulley hub having bosses upon the ends tapered inwardly, as described, of threaded sleeves fitted internally upon the tapering bosses, and divided collars *f*, threaded internally to fit the sleeves and provided with the clamping bolts and the internal flanges *g* to bear upon the ends of the bosses, as and for the purpose set forth. (3) The combination, with a pulley hub having bosses upon the ends tapered inwardly, as described, of threaded sleeves fitted internally upon the tapering bosses, lugs upon the hub to engage the sleeves and hold them from turning, and divided collars *f*, threaded internally to fit the sleeves and provided with clamping bolts and with the internal flanges *g* to bear upon the ends of the bosses, as set forth.

473,469. CYLINDER CASING, *E. W. Mackensie-Hughes, Chicago, Ill.*—*Filed July 3rd*, 1889.

Claim.—(1) The pressed steel cylinder casing formed of one piece of metal having a flat portion and the inwardly projecting flange B, substantially as described. (2) The cylinder casing A, having the inwardly projecting flange B and the outwardly projecting flange, all pressed from one piece of steel, substantially as described.

473,469



473,489. SEWERAGE SYSTEM, *S. E. Babcock, Little Falls, N.Y.*—*Filed April 22nd*, 1891.

Claim.—A covered or pipe sewer provided with a series of auxiliary inlet pipes entering the sewer at the side near the bottom thereof, the mouths of which

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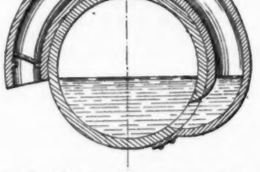
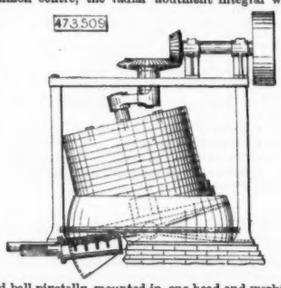


are located outside the sewer above the contemplated sewage level and face downward, substantially as shown and described.

473,509. VACUUM-PUMP, *W. L. Judson, New York, N.Y.*—*Filed September 25th*, 1890.

Claim.—(1) The combination, with an inclosing flange or casing, of a fixed and a movable convex head having their convex surfaces opposed to each other, and the said movable head being pivotally mounted on the centre of the fixed head, whereby a swinging motion may be imparted to the movable head to effect radial contact between the two heads progressive about their common centre. (2) The combination, with the fixed head having a convex upper face, of the opposing movable head having a convex lower face, the ball bearing between the two at their common centre, the radial abutment integral with

473,509

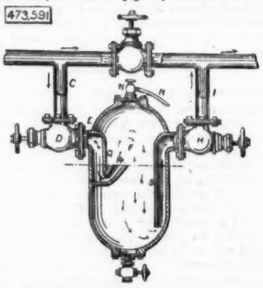


said ball pivotally mounted in one head and working between packing strips pivotally seated in a slot in the other head, the flange inclosing the space between the two heads, the inlet ports on one side of said abutment, the outlet ports on the other side of the same provided with check valves, the vertical driving shaft in line with the centres of the head provided with a crank arm, the shaft rising from the centre of the movable head and journalled in said crank arm, and the weights on said movable head counterpoised about its shaft, substantially as described.

473,591. DEVICE FOR SEPARATING OIL FROM FEED-WATER, *J. Reilly, Brooklyn, N. Y.*—*Filed August 14th*, 1891.

Claim.—(1) The chamber F, having the inlet pipe Q and outlet pipe S, combined with the escape valve N at the upper end of said chamber, the valve D and pipe C, connecting with said pipe Q, and the valve H and pipe I, leading from the pipe S, substantially as set forth. (2) The chamber F, having the inlet pipe Q, branch R, and outlet pipe S, combined with the

473,591



escape valve N for oil and air at the upper end of said chamber and the exit at the lower end of said chamber, substantially as set forth. (3) The main water pipe having the valve B and branch pipes C I, combined with the chamber F, the inlet and outlet pipes Q S in said chamber, the branch E and valve D, connecting said inlet pipe with the pipe C, the branch G and valve H, connecting said outlet pipe with the pipe I, the escape valve N at the upper end of said chamber, and the exit valve P at the base of said chamber, substantially as set forth.

ON THE CONSTRUCTION OF THE MODERN LOCOMOTIVE.

SECTION II.: FOUNDRY.—PART II.: THE USE OF STEEL CASTINGS.

THE introduction of trustworthy mild steel castings has replaced in the locomotive iron castings and forgings to the extent of about forty articles—illustrated by Figs. 87 to 108—including stays, gusset or otherwise; horn-blocks and axle-boxes, domes, covers, and safety valve seatings; spring links, brackets, and fire-box foundation rings; reversing shaft—Joy gear—motion plate and brake shaft; wheel centres, and to a limited extent, the unhammered crank axles made by a well-known firm in the North of England; one of which, supplied to the North British Railway for Engine 460, a heavy class of goods engine, working trains over the main lines, has run a mileage of 337,879 miles from 19th February, 1881, to the 27th April, 1892. This would, of course, be considered a good mileage for a mild steel forged axle, and is mentioned as an interesting fact; but under existing circumstances, the author does not deliberately advocate the use of steel castings for crank axles, although the experiment deserves encomium, and their adoption may be in the future an accomplished fact.

Advantages may be gained in many points by the adoption of steel castings, because they can be guaranteed to be sound, homogeneous, and free from internal strains, at the same time possessing the specified tenacity and ductility, contrasting favourably with built-up iron forgings and those from mild steel ingots, remarkable results as to ductility having come under the personal experience of the author. The tensile strength of unforged steel castings may be taken at about three to four times that of cast iron, therefore they may be considerably lighter than those of cast iron of equal strength, but whenever steel castings have to replace forgings or iron castings, the physical properties expected of those castings must be carefully taken into consideration, ductility being of much greater value than an unusually high tenacity, because it will give a greater amount of endurance and furnish ample warning of failures, excepting perhaps in a few cases, such as pins, where a great amount of wear and tear takes place, due to friction.

Steel castings are designed sometimes of a peculiar shape, and thin in section; when this is the case the steel founders have to contend with several difficulties in manufacture which could be avoided if the designer would keep in view the fact that steel castings should be as simple in design and as near uniformity in thickness as the circumstances of the case will admit, and of easy curves. It is contended by some American engineers that it is preferable to bolt several small castings to one large one, than to make a complicated casting with several branches, brackets, and projections; because each change in the form of the casting is a source of uncertainty. Steel wheel centres having the rim, boss, arms, and balance weight formed in one casting, contrast very favourably with built-up wrought iron centres, in which there are of necessity so many welds. To overcome the manufacturing difficulties, it is of the utmost importance that the rim should be in proportion to the arms, which are mostly of the oval section, the dimensions of the major and minor axes where they enter the boss being 4¼in. by 2in., and at the rim 3⅜in. by 1⅜in., Figs. 93, 94. A Sheffield authority opines that the most trustworthy job is made of wheel centres by having a strengthening rib on the inside of the rim and another rib at the boss into which the arms sink; also that in the case of crank boss wheels trouble is sometimes experienced when the counterbalance weight is heavy and relatively out of proportion to the other parts of the wheel. This large mass of material near the outside cools more slowly than the rest of the metal, thereby tending to draw it out of shape. Therefore, to obtain a thoroughly sound and good steel casting, the balance weight should be distributed over a sufficient number of spaces between the spokes. The adoption of steel roof-bars for fire-boxes has proved a success—see Fig. 15, vol. lxxiii., page 21. It enables the stays to be well proportioned, and convenient attachments for any form of sling stays desired can be easily added. With cast steel horn-blocks and axle-boxes there is greater strength without being cumbersome, greater security in running, and the risk of breakage is reduced to a minimum. Cast steel motion-plates give greater stability as frame stays. Being cast in one piece, there are not any rivets to work loose, as in the case of the built-up type, and, having greater strength and elasticity than cast iron, they can be made lighter, and there is not the same danger of breakage from sudden shocks. Generally, the remarks made as to the design of iron castings apply themselves doubly to steel castings, especially relating to fillets, abrupt changes, crystallisation, and the internal strains set up by unequal contraction.

The process and the raw materials should exercise a great influence upon the choice of steel castings, because they can be produced short and brittle, which no amount of subsequent annealing will rectify, for reasons well known to metallurgists. Up to the present, as far as the author is aware, the acid process has given the most uniformly successful castings, the basic and the Bessemer generally favour oxidisation of the metal during the process, and this incorporation of the oxides of iron is particularly obnoxious, not only in steel for castings, but generally, although upon occasions splendid castings have been made by these two latter processes, and at the same time containing a low percentage content of carbon. The enormous temperature required to produce fluidity, the difficulty in obtaining a suitable facing sand sufficiently refractory to withstand this great temperature, and at the same time porous enough to allow the gases to permeate through, besides the direct venting, and the mould being to a certain extent fragile enough to allow the greater contraction without pulling the casting, all tend to produce a product which cannot compete, as far as surface is concerned, with iron castings.

A peculiarity relating specially to steel castings is the great diversity of opinion and want of uniformity in specifications. Different engineers have different ideas both as regards the quality required for certain purposes, and the size of the test bars. The latter vary from 2in. to 10in. long, whilst an elongation of 20 per cent. to 10 per cent. is specified for the different lengths of 2in., 5in., and 8in. long. The same remarks relate also to the bending test bars. Different lengths, round and square in section, and the angle of deflection which the bars must sustain without fracture, are specified. Another difficulty is in nominating the grade of steel required. For instance, there should be a distinct difference in the specified grade for the steel for a gear wheel, and that of a locomotive driving wheel. In the former case, a material is required to withstand a considerable amount of wear and tear, whereas in the latter, the wear and tear takes place in the tyre, and the wheel centre is required to be tough, to withstand all the strains set up in passing over rough roads, crossings, and round curves, due consideration also being given to the shape, and whether the required product is to be in tension or compression. Therefore it would be conducive to general excellence, and facilitate the progress of steel castings to a desired end, to formulate a standard specification for the grade of material required for locomotive work, and recognise a standard size for both the tensile and bending test bars. This would be certainly advantageous to both consumers and founders.

At the same works, mentioned previously as the makers of unhammered crank axles, four different grades of material are manufactured, viz.:—(1) An extra soft steel of 28 tons to 32 tons per square inch ultimate tensile strength, and 25 per cent. to 15 per cent. elongation, which is applicable only to castings of fairly plain section, for all purposes when toughness is essential, such as wheel centres, cranks—marine or otherwise—cross-heads, motion-plates, horn-blocks, bogie frames, and locomotive work generally. This material would give a minimum elongation of 15 per cent. on 2in., and would be capable of bending while cold through an angle of from 90 deg. to 60 deg. respectively. (2) A medium steel of 32 tons to 35 tons per square inch ultimate tensile strength, and 15 per cent. to 8 per cent. elongation, suitable for heavy gearing, boiler seatings, &c. (3) A medium hard steel of 35 tons to 40 tons per square inch ultimate tensile strength, and from 8 per cent. to 3 per cent. elongation, suitable for all kinds of gearing, hydraulic cylinders, permanent way castings, tram wheels, and all castings where a maximum wearing capacity is required; and (4) a hard steel adapted for special purposes requiring great hardness and strength.

The annealing of steel castings is a matter of great importance, especially when toughness and ductility is essential. By this process the internal strains set up during casting in the different parts have a period of

TABLE I.

Test mark.	Analysis—per cent. Carbon.	Silicon.	Manganese.	Section. Length.	Diameter.	Stress. Original area, in sq. inches.	First per. set inflicted. Tons per sq. inch.	Breaking stress. Tons per sq. inch.	Fracture. Cohesive force.	Contraction of area. Per cent.	Elongation per cent. on 2in. length.	Remarks.
S A 13	·30	·22	·63	1·75	·533	·223	27·0	31·0	55·1	43·8	24	Annealed.
,,	,,	,,	,,	,,	,,	,,		30·4	55·1	43·8	24	Do.
,,	,,	,,	,,	,,	,,	,,	19·2	33·4	56·4	41·0	24	Do.
								31·6		42·8	24	Average.
H A 13	,,	,,	,,	,,	,,	,,		33·6	46·6	26·84	16	Not annealed.
										28·7	=	Percentage advantage.
S A 18	·35	·23	·61	1·75	·533	·223		33·0	56·0	41·0	22·2	Annealed.
,,	,,	,,	,,	,,	,,	,,	19·0	36·0	57·1	37·06	21·5	Do.
,,	,,	,,	,,	,,	,,	,,		Spoiled in tooling.				Do.
								34·5		39·03	21·8	Average.
H A 18	,,	,,	,,	,,	,,	,,		Spoiled in tooling.				Not annealed.
												Percentage advantage.
S A 48	·50	·41	·66	1·75	·533	·223		44·0	52·9	16·8	12	Annealed.
,,	,,	,,	,,	,,	,,	,,	24	45·2	48·23	6·3	5	Do.
,,	,,	,,	,,	,,	,,	,,		42·2	48·06	12·3	9	Do.
								43·8		11·8	8·6	Average.
H A 48	,,	,,	,,	,,	,,	,,		44·4	46·2	4·13	2	Not annealed.
										27·1	=	Percentage advantage.
S A 60	·77	·46	·67	1·75	·533	·223		39·8	40·34	1·35	1·0	Annealed.
,,	,,	,,	,,	,,	,,	,,		39·0	40·34	3·3	1·9	Do.
,,	,,	,,	,,	,,	,,	,,	32·4	33·6	34·21	1·8	1·5	Do.
								37·4		2·15	1·4	Average.
H A 60	,,	,,	,,	,,	,,	,,		36·4	36·61	0·8	Nil	Not annealed.
										10·2	=	Percentage advantage.
S A 82	·96	·62	·64	1·75	·533	·223		31·0	31·71	2·24	2	Annealed.
,,	,,	,,	,,	,,	,,	,,		38·0	38·3	0·80	1	Do.
,,	,,	,,	,,	,,	,,	,,		35·6	36·2	1·80	1	Do.
								34·8		1·61	1·3	Average.
H A 82	,,	,,	,,	,,	,,	,,		37·0	37·3	0·8	Nil	Not annealed.

TABLE II.

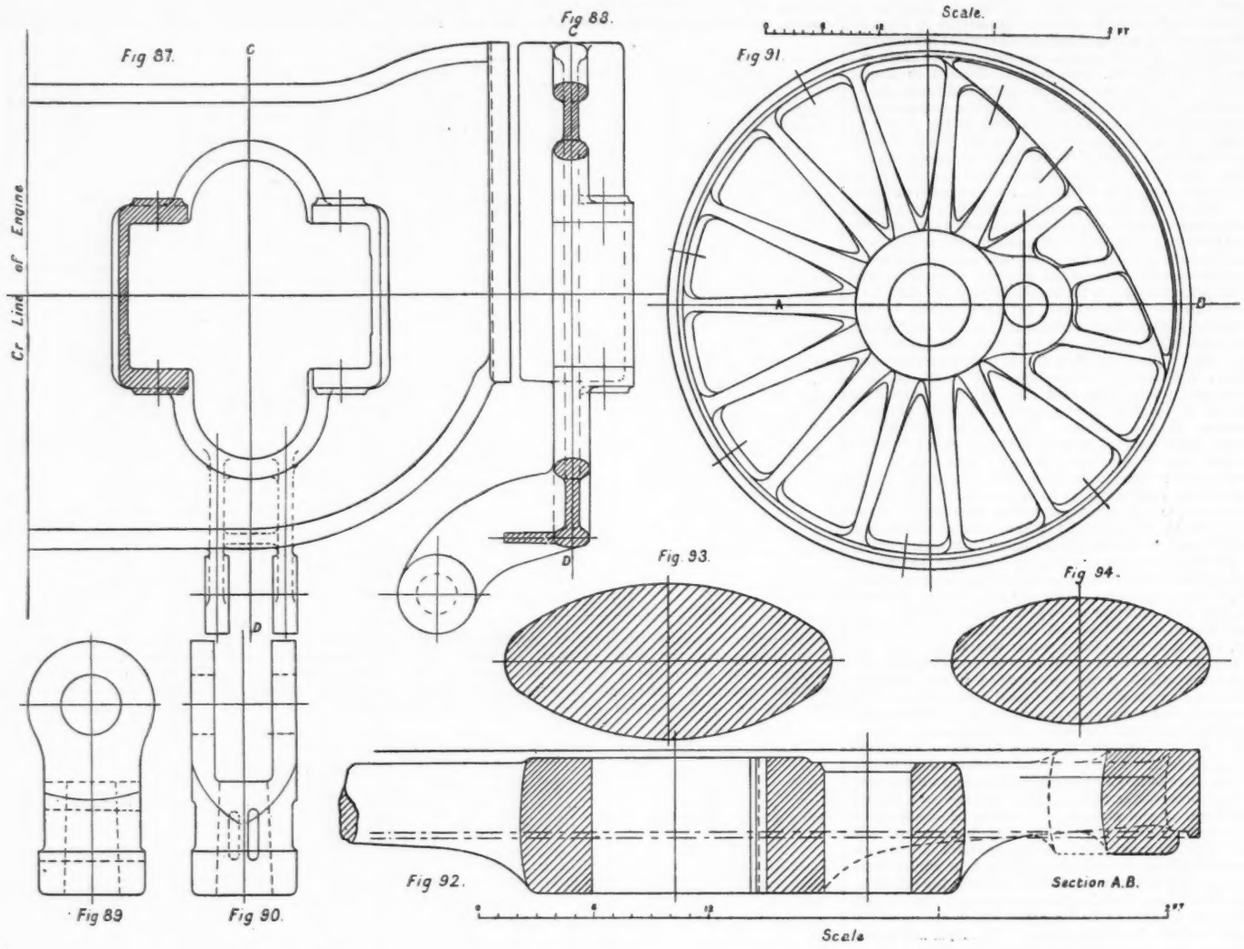
Test mark.	Analysis. Carbon.	Silicon.	Manganese.	Section. Length.	Diameter.	Area.	Stress. First per. set. Tons per sq. inch.	Breaking. Tons per sq. inch.	Fracture. Cohesive force.	Reduced area. Inches.	Contraction of area. Per cent.	Elongation in percentage in a length of:— 5in.	4in.	2in.	Remarks.
028	·41	·32	·47	5	·745	·4359	15·26	33·79	36·8	·4003	8·16	12	—	19	Not annealed } Taken from the git of a hydraulic rivetter casting
021	·26	—	—	,,	·754	·4464	—	32·8	48·17	·2734	38·7	22	—	37	Annealed }
024	·47	·30	·54	,,	·741	·4310	15 5	32·1	33·10	·418	2·9	4·16	—	6	Not annealed } Taken from the git of a hydraulic cylinder casting
025	·35	—	—	,,	·710	·3959	13·26	36·6	50·66	·284	28·11	14·6	—	24	Annealed }
151 S	·35	—	—	,,	·754	·4464	11·7	32·3	50·27	·2734	38·7	15	—	28	Do. }
027	·42	·33	·49	,,	·758	·4512	19·8	24·01	24·80	·4382	2·8	1	1	—	Not annealed { Taken from the git of a hornblock.
020	·42	—	—	,,	·756	·4488	11·8	28·4	34·30	·375	15 9	13	—	16	Annealed {
S 25	·47	·33	·47	,,	·724	·4166	13·12	30 08	40·36	·3067	23·05	21·9	23·4	28	Do. } Taken from the gits of pinions.
059	·41	—	—	,,	·757	·4500	19·54	38·19	43·05	·399	11·28	—	11·5	13	Do. }
060	·41	—	—	,,	·757	·4500	19·04	37·69	42·37	·400	11·04	—	10	12	Do. }
0157	·35	—	—	,,	·754	·4465	19·0	38·3	45·60	·375	16·01	14·5	14·5	16	Do. } Taken from the gits of hornblocks & axle-boxes.
0158	·35	—	—	,,	·754	·4465	18·69	38·5	48·35	·3462	22·46	19·25	20	22·5	Do. }
0159	·35	—	—	,,	·747	·4382	18·64	38·4	47·59	·3536	19·30	17·8	18	21·5	Do. }
06567	—	—	—	,,	·539	·2281	18·60	31·32	59·83	·1194	47·65	—	—	26·5	Do. 4ft. 4in. wheel centre.
06568	—	—	—	,,	·548	·2358	15·19	30·24	56·77	·1256	46·73	—	—	28·0	Do. 2ft. 6in. wheel centre.
06883	—	—	—	,,	·540	·2290	17·5	35·6	39·92	·2042	10·8	—	—	14·5	Do. Trolley wheel.
06915	—	—	—	,,	·540	·2290	13·62	28·4	34·10	·1907	16·7	—	—	32·0	Do. Piston.

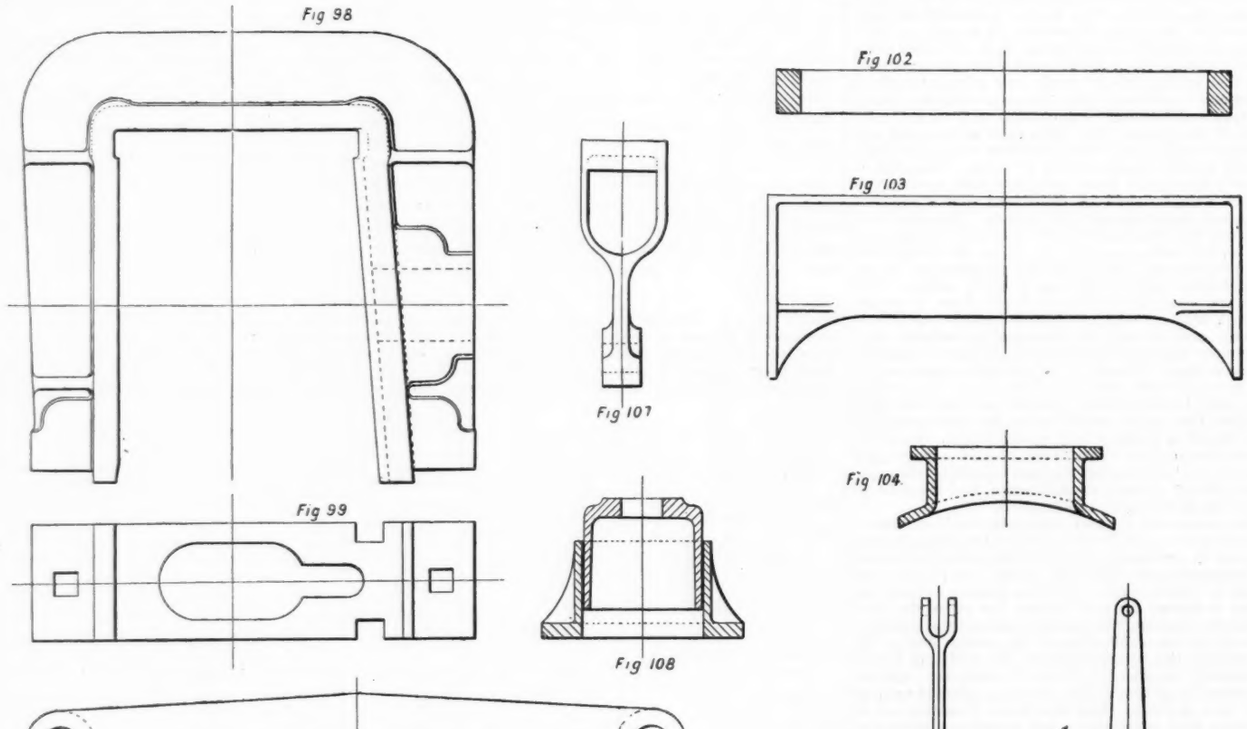
TABLE III.

Test mark.	Section. Length of the bar.	Distance between supports.	Size of specimen.	B × D²	Stress. Elastic limit.	Maximum stress in tons per square inch.	Strain. Deflection.	Angle through which the specimen passed.	Remarks.
Δ 79	Inches. 14	Inches. 10	in. sq. 1¼	1·9531	Tons per sq. in. 24·00	45·25	Inches. 5·73	Deg. 127	Not broken.
,, 84	,,	,,	,,	,,	27·77	56·53	3·55	87·5	Broken.
,, 85	,,	,,	,,	,,	27·77	49·37	1·12	29·5	Do.
,, 87	,,	,,	,,	,,	28·11	54·85	5·80	126	Not broken.
,, 89	,,	,,	,,	,,	27·42	51·42	5·50	119·5	Do.
,, 90	,,	,,	,,	,,	27·42	51·42	5·40	119	Do.
,, 96	,,	,,	,,	,,	28·11	51·43	5·84	125	Do.
,, 97	,,	,,	,,	,,	27·42	51·77	5·71	124	Do.

STEEL CASTINGS FOR LOCOMOTIVE ENGINES

(For description see page 25)





time whilst at a uniform temperature, and when the crystalline structure is changed into an amorphous or plastic state, to adjust themselves to one another, and, according to Sir William Siemens, it must therefore be most disadvantageous to allow the castings to cool right down, whereby these differences of strain would be brought to a maximum, and very likely cause an evil that was preventible. In order to anneal a casting to the greatest advantage, it should be removed from the mould to the annealing furnace without allowing it to cool; but no doubt a considerable amount of judgment must be exercised in removing a casting hot from the mould, and it is quite sufficient to specify that each casting must be thoroughly annealed, and allowed to cool gradually, in such a manner that there shall be no undue strain in any part.

Table I. gives the results of some experiments on the tensile strength of specimens taken from ordinary castings, without any subsequent hammering, in order to ascertain how the mechanical properties of steel castings are effected by annealing, and also by its chemical composition. Five groups, each containing four specimens, were tested; the first three pieces in each group being annealed and the last in each unannealed—nature of the castings No. 1.

The advantage gained by annealing may be expressed by a percentage, acting upon the suggestion made by Sir J. Whitworth at the Manchester meeting of the Institute of Mechanical Engineers in 1875, in which he proposed a mode of comparison of metals by taking the sum of their tensile strengths and percentage elongation; but in the case before us, to this sum that of the percentage contraction of area will be added, and from Table I. it is seen that varying with the grade of material, this advantage of the annealed over the unannealed is from 10 to 28 per cent.

Table II. gives some further results, obtained in a series of experiments conducted by the same authority as Table I., for the purpose of ascertaining how the tensile strength of steel castings is affected by the annealing process.

From Table II. it will be observed that the annealing process causes a considerable reduction of the combined carbon, the carbons being ascertained by the colour test before and after annealing. The figures clearly indicate the fact, that to the extent shown, the combined or hardening carbon has been changed into graphite or amorphous carbon, which latter does not affect the colour test. Under conditions which are not quite understood, a large proportion of the carbon may separate into the graphitic or amorphous condition, and it is this circumstance which is the cause of this noticeable change. The total carbon, when ascertained by the combustion method, remains after annealing exactly what it was before. There still remains, however, a possibility that the content of carbon in the surface of the casting may be richer, owing to the absorption from the mould, and that the annealing causes a skin of oxide of iron, which would act as a medium for the combustion of some of this carbon in the surface. A similar change has been noticed by manufacturers of mild steel ingots, and the users of iron castings exposed to long continued heat, which does appreciably lessen the content of skin carbon, and causes a peculiar phenomenon, but these drillings were taken from the body of the casting and all surface ones were discarded. It is clearly seen on comparing these tabulated results, that while the tensile resistance of the original area is scarcely affected by the annealing process, the ductility of the material is very considerably increased.

Tables III. and IV. give the results obtained in a series of experiments on the transverse strengths and torsional resistance of unhammered, annealed steel castings, the specimens being cut from crank webs—same authority as Tables I. and II., No. 1.

Table V. gives further results, by different authorities, of the physical properties of steel castings.

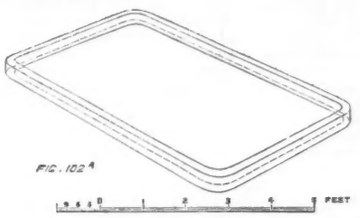
It may therefore be concluded that steel castings can be supplied very much superior to iron castings or forgings, and to rival those forgings made of hammered or wrought steel, although it must be remembered that in a crank axle or any other forging, hammering makes a hard skin, which never gets any hotter as the forging cools, consequently internal strains are set up, and the centre metal is of little use from a physical point of view, and the cruciform shape taken by a pipe in an ingot is well known.

TABLE IV.

Test mark.	Length for torsion.	Diameter in inches.	Original area in square inches.	Elastic limit in tons per sq. in.	Maximum stress in tons per sq. in.	Angle through which piece twisted for two diameters long.
						Deg.
S 74[1]	2·256	1·128	1·0	7·617	31·015	274
S 74[2]	,,	,,	,,	8·161	30·470	275
S 74[1]	,,	,,	,,	9·794	32·647	282
S 74[2]	,,	,,	,,	9·794	29·926	213
013	,,	,,	,,	7·610	30·400	278
014	,,	,,	,,	9·790	31·010	271
015	,,	,,	,,	7·610	31·550	285
016	,,	,,	,,	8·700	32·640	316

TABLE V.

Test mark.	Maker.	Length of specimen.	Section. Dimensions. Inches.	Section. Area. Square inches.	Stress. Elastic limit. Tons per sq. inch.	Stress. Breaking weight. Tons per sq. in.	Strain. Ultimate set. Inches.	Strain. Per cent. of original length.	Fracture. Area. Square inches.	Fracture. Contraction. Per cent.	Fracture. Appearance.	Bends.	Remarks.
												Deg.	
C 337	No. 2	2	·7979	·5	—	32·5	—	29·0	—	40·4			
C 2¼ B		,,	,,	,,	—	32·5	—	27·9	—	33·4			
C 147		,,	,,	,,	—	34·5	—	27·7	—	35·2			
C 2¼ A		,,	,,	,,	—	32·0	—	26·8	—	30·9			
C 111		,,	,,	,,	—	40·0	—	19·0	—	20·0			
C 117		,,	,,	,,	—	45·0	—	15·0	—	18·0			
C 1		,,	,,	,,	—	52·0	—	4·0	—	6·3			
C 2		,,	,,	,,	—	56·8	—	4·0	—	5·5			
C 3		,,	,,	,,	—	64·0	—	6·0	—	8·0			
		,,	—	—	—	26·0	—	36·5	—	40·4			1st centre arm
		,,	—	—	—	26·0	—	37·6	—	50·0			,, ,, rim
		,,	—	—	—	27·0	—	28·5	—	33·6			,, ,, bal. weight
		,,	—	—	—	26·5	—	20·6	—	22·3			2nd ,, arm
1958	Various	—	·7979	·5	—	36·9	—	—	·3632	27·3	Granular	35	
3221		2	·620	·301	—	30·0	·64	32·0	·1520	49·5	Fibrous	to	
3222		,,	·565	·250	—	32·5	·55	27·5	·1450	42·0	,, ...	80	
3223		,,	·540	·229	—	31·1	·60	30·0	·1190	48·0	,, ...		
3224		,,	·500	·196	—	32·6	·55	27·5	·1070	45·4	,, ...		
3435		,,	·560	·246	—	32·5	·27	13·5	·2200	10·5	Granular and fibrous		
3436		,,	·565	·250	—	31·2	·34	17·0	·2000	20·0	,, 30% ,,		
3437		,,	·565	·250	—	31·6	·60	30·0	·1350	46·0	Fibrous		
3438	No. 3	2	—	·237	18·6	32·4	·64	32·0	·1194	49·6	100% fibrous	180	Not broken. Size ⅝" and [¾" radius
3439		,,	—	·216	18·5	32·9	·60	30·0	·1244	42·3	,, ,, ...	,,	Do.
3441		,,	—	·223	18·8	32·2	·62	31·0	·1152	48·3	,, ,, ...	,,	Do.
3442		,,	—	·227	17·3	31·7	·65	32·5	·1134	50·0	,, ,, ...	,,	Do.
3443		,,	—	·227	19·8	37·0	·45	22·5	·1661	26·8	20% fib., 80% gran.	,,	Do.
3444		,,	—	·225	18·3	31·6	·62	31·0	·1225	45·5	Fibrous	,,	Do.
3445		,,	—	·214	17·7	32·2	·60	30·0	·1134	46·9	,, ...	,,	Do.
3472		,,	—	·223	20·1	35·2	·50	25·0	·1520	31·8	4% fib., 96% gran.	115	Broken. Size ⅝" and [7/16" radius
3473		,,	—	·220	16·5	30·4	·65	32·5	·1134	48·0	100% fibrous	180	Not broken.
3474		,,	—	·212	19·6	32·4	·60	30·0	·1134	46·5	,, ,, ...	85	Broken.
3475		,,	—	·220	17·8	32·3	·65	32·5	·1194	45·7	,, ,, ...	180	Not broken.
3476		,,	—	·220	18·5	34·6	·52	26·0	·1520	30·9	10% fib., 90% gran.	100	Broken.
3477		,,	—	·224	18·4	32·0	·60	30·0	·1452	35·1	100% fibrous	180	Not broken.
3478		,,	—	·233	18·5	35·0	·42	21·0	·1960	15·8	100% granular... ...	180	Do.
3479		,,	—	·220	18·6	31·4	·60	30·0	·1194	45·7	100% fibrous	180	Do.

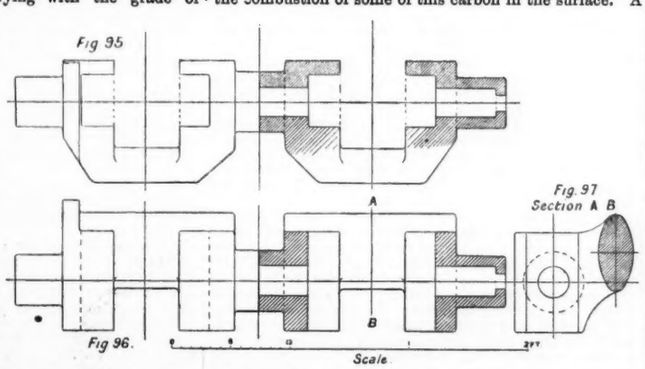


From the foregoing results it would be reasonable to specify that the castings shall be made in close grained steel of uniform quality, perfectly sound, free from honey comb or any other defects, and of 28 to 34 tons tenacity per square inch, with a minimum elongation of 15 per cent. on 2in. The bending tests to be made upon bars 1in. or 1¼in. square, which should be capable of bending cold without fracture over a radius not greater than about one and a-half times the thickness of the sample, and through an angle depending upon the ultimate strength. This angle to be not less than 90 deg. at 28 tons, and 60 deg. at 34 tons per square inch, and in proportion for strengths between those limits. At the present time all locomotive castings are made to the above specification when nothing otherwise has been specified, and all the engine castings for the Admiralty are made to the above limits. The castings to be thoroughly annealed for reasons already stated.

The wheel centres are required by some users to be rough turned, leaving ⅛in. for finishing, where they have to be finished bright. One wheel in fifty to be supplied by the contractor free of cost, selected from the bulk, tested to destruction, and from this the tensile and bending test samples will be taken, the results of which will be accepted as the average quality of the whole. It is further required, by some users of wheel centres, that each be dropped in a running position, on the end of a spoke, from a height of 2ft., and allowed to fall upon a rail secured to the top of an ingot of at least 2 tons weight, after which the wheel must be turned round through an angle of 90 deg., and dropped again in a similar manner. Each casting must be then slung up and hammered with a 7lb. hammer, to ascertain that it is sound. Clauses as to inspection and warranty are inserted to suit the purchaser; the latter is generally for twelve months from the date of commencing to work.

As far as the analysis is concerned, probably that is the best left in the hands of the steel maker, because so much depends upon the process. Sometimes a good analysis gives worse physical results than an inferior one, owing to the working of the charge during the earlier or latter stages of the heat; however, castings having an analysis of C ·18 to ·28, Si ·20 to ·40, S ·02 to ·07, P traces to ·04, Mn ·18 to ·5, would give similar results to those tabulated in Table V. under the second authority, providing that the heat had been worked to the best advantage. Finally, in a great number of observations made by the author for Mr. Aspinall, it was observed throughout that the highest carbon with simultaneous high silicon gave the worst castings, and the best results were when the carbon is ·28 per cent., or below, or when the content of carbon is from 10 to 26 per cent. less than that of silicon.

In Fig. 87 is seen one-half of the motion plate, from the centre line of the engine to the right frame, with its forked attachment for securing one end of the anchor link of Joy's motion, whilst an end view is shown in Fig. 88. Two views of the crosshead are given in Figs. 89 and 90, to which may be cast sufficient metal to be drawn down in the forge to the required dimensions of the piston rod. The driving wheel centre is given in Fig. 91, the leading and trailing being identical, with the exception of the balance weights, which are of course very much lighter; Fig. 92 being a half section through the crank pin boss. Figs. 93 and 94 are sections of the arms at the top and bottom. Minuter reference has already been made to the design of wheel centres, as well as the hornblock, which is shown in Fig. 98, with its keep, Fig. 99. This hornblock is of a useful design, but is frequently modified to suit the various types of locomotives built by different engineers. Figs. 100 and 101 give two views of the brake hanger, which is swung from the frame at one end, coupled up to the brake cylinder by means of suitable connecting rods from the other, and having the cast iron brake block attached in the centre, Figs. 105 and 106 being the tender brake shaft. The fire-box foundation ring is given in cross section in Fig. 102 and in isometric Fig. 102A. The cross stay between



the frames in front of the fire-box is shown in Fig. 103, and the safety valve seating in Fig. 104. Similar designs to Fig. 104 are adopted for the mud collector in the barrel, just in front of the fire-box, and also where cast steel domes have been used, they required a similar seating. Fig. 107 is the tender spring link, and the draw bar, with its spring box, is shown in section in Fig. 108.

THE BRITISH NAVY UNDER THE PRESENT ADMINISTRATION.

Last week we dealt with the question of the considerable increase which has taken place in the battleship portion of the British Navy, since the advent of the present Administration in 1886. To-day we propose dealing in a similar manner with the unarmoured cruisers and smaller vessels—excluding torpedo boats. As before, we have prepared a tabular statement giving the names, armaments, and speeds of all vessels of over 1000 tons; it appeared unnecessary to detail severally the smaller ships and torpedo gunboats, so they are lumped together in the recapitulation below. Instead of placing the whole of the unarmoured vessels of 1892 alphabetically, we have classified them for convenience into various sections, in two consecutive columns. First come all the ships of 1886 and 1892 which correspond, and which occupy the whole of the first column. It will be observed here that seventeen old vessels have been withdrawn from the Navy List, during the six years that have elapsed, and that the total to be carried forward to the second column for 1892 comprises sixty-three ships. The eighty ships in the first column constituted the sum total of unarmoured vessels over 1000 tons in the British Navy of 1886. And they included a number of ships which were worn out, hence the withdrawal alluded to. The main interest must therefore concentrate itself upon the second column, which contains the most recent, the most powerful, and the swiftest of our deck-protected cruisers, the value of which, to a country like Great Britain, with an enormous mercantile marine to be protected, it is perhaps impossible to over-estimate.

Eliminating the seventeen old wooden sloops and corvettes which have been withdrawn since 1886, we find that the strength of the fleet has more than doubled itself in numbers, having jumped from sixty-three vessels to one hundred and thirty-three, the gunboats and smaller craft having increased in similar proportion. But, when we examine the component elements of those classes which go to make up the numbers of the second column, we find that quality has improved in a far higher ratio even than quantity. To put it in another way, there is absolutely no comparison between column one and column two. The forty-two new cruisers, comprising a portion of the naval programme of 1889, are the *pièce de resistance* of the second column. The nine first-class, twenty-nine second-class, and four third-class cruisers are arranged alphabetically in classes, commencing with the Crescent and ending with the Phœbe. But apart from the preponderating influence exerted by the numbers of ships belonging to the naval programme, the list of other third-class cruisers and sloops, commencing with the Magicienne and ending with the Nymphe, is a most formidable one, although we cannot help regretting that these last-named smaller ships were not designed for a higher rate of speed than 14·50 knots. Five of the first-class torpedo gunboats have been included, as they have a displacement of 1070 tons each. Glancing further down at the recapitulation, we find that the almost phenomenal increase of ninety-three ships, with a displacement of 235,000 tons, and of 1431 guns, has been the result of the six years' splendid work of the present Administration in this direction alone. If we add to these figures the increased provision made during the same period for the ironclad navy, as pointed out in our columns last week, we shall arrive at the astounding total of 103 more ships, with an additional displacement of 350,000 tons, and an increased armament of 2500 guns, as representing the outline of work done for the Navy.

But the details within that outline, if gone into, would display, in far more remarkable proportions, the immensity of the revolution which has been effected in our fleet. For instance, our statement shows the Comus class as re-armed. Were the old muzzle-loading guns, extant in 1886, to be inserted in our columns, it would be found that about 200 muzzle-loaders have been replaced by breech-loaders amongst the cruisers alone, whilst fully 300 ordinary breech-loading guns of all calibres have been added to the Navy, irrespective of the 572 heavy quick-firing guns of 4·7in. and 6in. calibre, which are the creation of this period. The improvement in speed has developed in like ratio. The highest proportions of engine power to displacement in 1886 were in the Polyphemus, Iris, and Mercury; viz., 5520 to 2640, 7330 to 3730, and 7290 to 3730 respectively. But three to one is an ordinary proportion in the new cruisers, producing a speed of 20·50 knots, and excellent results are anticipated from the improved first-class torpedo gunboats, in which the proportions will be a great deal higher. Then, protection of the gun crews, which was a matter scarcely considered prior to 1886, yet one of vital importance, has been thoroughly thought out. Not only are excellent splinter-proof shields and casemates constructed in rear of the gun positions, but armoured trunks and expense magazines are contrived in the vicinity of the guns, so that danger is reduced to a very considerable extent. The effect of this condition upon fire steadiness would doubtless be felt in action. Lastly, the comfort of the men and the roominess of stokeholds has been vastly improved, though a good deal has still to be done in this direction.

We do not think another word is necessary to establish the fact, "beyond a peradventure," that no six years of our country's history has seen so important and rapid a development of our "first great line of defence" as those which have elapsed between 1886 and 1892.

Unarmoured Vessels, Complete and Building, at beginning and end of present Administration.

In 1886.	In 1892.	M. L. guns.	B. L. guns.	Machine and Q.F. small.	4·7″ and 6″ Q.F.	Speed.	Date of launch.
						Knots.	
Active... ...	Do.	2	10	9	—	15·10	1869
Alacrity ...	Do.	—	4	6	—	17·00	1885
Amphion ...	Do.	—	10	16	—	17·00	1883
Archer ...	Do.	—	6	10	—	17·00	1885
Arethusa ...	Do.	—	10	17	—	17·00	1882
Bacchante ...	Do.	10	4	12	—	15·06	1876
Boadicea ...	Do.	12	2	16	—	14·70	1875
Brisk	Do.	—	6	10	—	17·00	1886
Briton... ...	—	14	—	6	—	13·13	1869
Buzzard ...	Do.	—	8	8	—	14·50	1887
Calliope ...	Do.	—	16	10	—	15·00	1884
Calypso ...	Do.	—	16	10	—	13·75	1883
Canada ...	Do.	—	10	8	—	13·00	1881
Caroline ...	Do.	—	14	8	—	13·10	1882
Carysfort ...	Do.	14	—	6	—	12·96	1878
Champion ...	Do.	—	12	10	—	13·00	1878
Cleopatra ...	Do.	—	12	10	—	13·00	1878
Comus... ...	Do.	8	4	8	—	12·93	1878
Conquest ...	Do.	14	—	6	—	13·00	1878
Constance ...	Do.	14	—	6	—	13·72	1880
Cordelia ...	Do.	—	10	10	—	13·00	1881
Cormorant...	Do.	6	—	4	—	11·31	1877
Cossack ...	Do.	6	—	10	—	17·00	1886
Curaçoa ...	Do.	—	12	10	—	13·00	1878
Diamond ...	—	12	—	6	—	12·56	1874
Dido	—	12	—	6	—	13·50	1869
Druid	—	14	—	6	—	12·90	1869
Eclipse ...	—	12	—	—	—	12·90	1867
Emerald ...	Do.	—	12	7	—	13·20	1876
Encounter ...	—	14	—	6	—	13·19	1873
Espiegle ...	Do.	—	10	8	—	11·50	1880
Euryalus ...	Do.	12	2	15	—	14·72	1877
Fearless ...	Do.	—	4	10	—	17·27	1886
Forth	Do.	—	12	15	—	18·00	1886
Gannet ...	Do.	5	2	6	—	11·53	1878
Garnet ...	Do.	—	14	7	—	13·00	1877
Hecla	Do.	4	2	14	—	11·7	1878
Heroine ...	Do.	—	8	4	—	13·11	1881
Hyacinth ...	Do.	—	8	4	—	13·10	1881
Inconstant...	Do.	16	6	13	—	16·20	1868
Iris	Do.	—	13	12	—	18·00	1877
Juno	—	8	—	6	—	10·87	1867
Kingfisher ...	Do.	6	—	6	—	11·60	1879
Leander ...	Do.	—	10	17	—	17·00	1882
Mercury ...	Do.	—	13	13	—	18·00	1878
Mersey ...	Do.	—	12	14	—	18·00	1885
Miranda ...	—	6	—	4	—	11·00	1879
Mohawk ...	Do.	—	6	10	—	17·00	1886
Mutine ...	Do.	—	10	8	—	12·10	1880
Opal	—	12	—	6	—	13·13	1875
Osprey ...	—	6	—	4	—	16·64	1876
Pegasus ...	—	6	—	4	—	11·47	1878
Pelican ...	Do.	—	8	4	—	12·00	1877
Penguin ...	Do.	2	—	2	—	11·00	1876
Phæton ...	Do.	—	10	15	—	17·00	1883
Polyphemus ...	Do.	—	—	8	—	17·80	1881
Porpoise ...	Do.	—	6	10	—	17·00	1886
Pylades ...	Do.	—	14	8	—	13·00	1884
Racoon ...	Do.	—	6	10	—	17·00	1887
Raleigh ...	Do.	8	16	12	—	15·50	1873
Rapid	Do.	—	12	4	—	13·10	1883
Rover	Do.	—	14	8	—	14·53	1874
Royalist ...	Do.	—	12	4	—	13·10	1883
Ruby	Do.	12	—	6	—	12·28	1876
Sapphire ...	—	12	—	6	—	13·58	1874
Satellite ...	Do.	—	8	4	—	13·10	1881
Scout	Do.	—	4	10	—	17·00	1885
Serpent ...	—	—	6	20	—	17·00	1887
Severn... ...	Do.	—	12	15	—	18·17	1885
Surprise ...	Do.	—	4	6	—	17·00	1885
Swallow ...	Do.	—	8	8	—	13·50	1885
Tartar... ...	Do.	—	6	10	—	17·33	1886
Tenedos ...	—	12	—	6	—	12·90	1870
Thalia... ...	—	8	—	2	—	11·14	1869
Thames ...	Do.	—	12	15	—	18·00	1885
Thetis... ...	—	14	—	6	—	13·39	1871
Tourmaline ...	Do.	—	14	8	—	12·62	1875
Turquoise ...	—	12	—	6	—	12·32	1876
Volage ...	Do.	2	10	10	—	15·30	1874
Wild Swan...	Do.	—	8	4	—	11·35	1876
80 ships	63 ships	327	500	684	Nil.	Carried	forward

In 1886.	In 1892.	M. L. guns.	B. L. guns.	Machine and Q.F. small.	4·7″ and 6″ Q.F.	Speed.	Date of launch
						Knots.	
Brought forward							
80 ships	63 ships	327	500	684	Nil.	—	—
42 Cruisers of programme of 1889. First-class Cruisers.	Blake	—	12	23	—	19·12	1889
	Blenheim ...	—	12	23	—	20·40	1890
	Crescent ...	—	1	24	12	19·50	1892
	Edgar	—	2	24	10	20·50	1890
	Endymion ...	—	2	24	10	19·75	1891
	Gibraltar ...	—	2	24	10	19·50	Bld'ng
	Grafton ...	—	2	24	10	19·75	1892
	Hawke ...	—	2	24	10	19·75	1891
	Royal Arthur	—	1	24	12	19·50	1891
	St. George...	—	2	24	10	19·50	1892
	Theseus ...	—	2	24	10	19·75	Bld'ng
Second-class Cruisers.	Ædus... ...	—	—	13	8	19·75	1891
	Andromache	—	2	13	6	20·00	1890
	Apollo... ...	—	2	13	6	20·00	1891
	Astræa... ...	—	—	13	10	19·50	Bld'ng
	Bonaventure	—	—	13	10	19·50	Do.
	Brilliant ...	—	—	13	8	19·75	1891
	Cambrian ...	—	—	13	10	19·50	Bld'ng
	Charybdis ...	—	—	13	10	19·50	Do.
	Flora	—	—	13	10	19·50	Do.
	Forte	—	—	13	10	19·50	Do.
	Fox	—	—	13	10	19·50	Do.
	Hermione ...	—	—	13	10	19·50	Do.
	Indefatigable	—	—	13	8	19·75	1891
	Intrepid ...	—	—	13	8	19·75	1891
	Iphigenia ...	—	—	13	8	19·75	1891
	Latona ...	—	2	13	6	20·11	1890
	Melampus ...	—	2	13	6	20·00	1890
	Naiad	—	2	13	6	20·00	1891
	Pique	—	2	13	6	19·75	1890
	Rainbow ...	—	2	13	6	19·75	1891
	Retribution	—	2	13	6	19·75	1891
	Sappho ...	—	—	13	8	20·00	1891
	Scylla	—	—	13	8	20·00	1891
	Sirius	—	2	13	6	19·75	1890
	Spartan ...	—	2	13	6	20·44	1891
	Sybille ...	—	2	13	6	20·00	1890
	Terpsichore	—	2	13	6	20·50	1890
	Thetis... ...	—	2	13	6	20·00	1890
	Tribune ...	—	2	13	6	20·00	1891
Third-class Cruisers.	Pallas	—	—	12	8	19·10	1890
	Pearl	—	—	12	8	19·00	1890
	Philomel ...	—	—	12	8	19·00	1890
	Phœbe ...	—	—	12	8	19·00	1890
	Magicienne	—	6	13	—	19·75	1888
	Marathon ...	—	6	13	—	19·75	1888
	Medea	—	6	13	—	20·00	1888
	Medusa ...	—	6	13	—	20·00	1888
	Melpomene	—	6	13	—	19·75	1888
	Katoomba ...	—	—	12	8	18·20	1889
	Mildura ..	—	—	12	8	18·20	1889
	Ringaroona	—	—	12	8	18·20	1890
	Tauranga ...	—	—	12	8	19·00	1889
	Wallaroo ...	—	—	27	8	18·20	1889
Small cruisers & sloops	Barham ...	—	—	6	6	16·50	1889
	Barracouta...	—	—	6	6	16·50	1889
	Barrosa ...	—	—	6	6	16·50	1889
	Basilisk ...	—	8	8	—	14·50	1889
	Beagle ...	—	8	8	—	14·50	1889
	Bellona ...	—	—	6	6	16·50	1890
	Blanche ...	—	—	6	6	16·50	1889
	Blande ...	—	—	6	6	15·50	1889
	Daphne ...	—	8	8	—	14·50	1888
	Nymphe ...	—	8	8	—	14·50	1888
	Vulcan ...	—	—	12	8	18·54	1889
First-class torpedo gunboats.	Dryad ...	—	—	4	2	19·00	Bld'ng
	Halcyon ...	—	—	4	2	19·00	Do.
	Harrier ..	—	—	4	2	19·00	Do.
	Hazard ...	—	—	4	2	19·00	Do.
	Hussar ...	—	—	4	2	19·00	Do.
Total of ships over 1000 tons displacement	Total of ships over 1000 tons displacement	327	630	1617	440	—	—
		Deduct armament of 17 old ships withdrawn from Navy between 1886 and 1892.					
1886	1892	174	6	100	Nil.	—	—
80 ships	133	153	624	1517	440	—	—

1511 2734

1886.

	Nos.	Guns.
Ships over 1000 tons	80	1511
Smaller vessels and gunboats	39	231
(Displacement, 219,000 tons)	119	1742

1892.

	Nos.	Guns.
Ships over 1000 tons	133	2734
Smaller vessels, torpedo gunboats, and gunboats	79	439
(Displacement, 454,000 tons)	212	3173

Difference, displacement, 235,000 tons; 93 ships; 1431 guns.

MANCHESTER SHIP CANAL.

The embankment opposite the Weston Point entrances is now being united, thus closing the direct access to the river Mersey against the traffic of the Bridgewater Canal and docks as well as the Weaver navigation. The Manchester Ship Canal Company has rented the docks and basins at Weston from the Weaver trustees, and accommodates coasters drawing 10ft. and under at Weston. These are lightened in Weaver Pool to enable them to proceed from Weston Marsh Lock along the Weston Canal to Weston Docks, and the barge traffic to Runcorn and Manchester passes along the same route, and over the Runcorn and Weston Canal to the Bridgewater system.

We have frequently called attention to the importance of the water space at the junction of the Weaver and Manchester Ship Canal, which was curtailed by the line of the latter being driven inland by the House of Commons Committee. This area is now known as Weaver Pool, and the following extract from the *Manchester Guardian* shows that a brisk trade is being done here. We are surprised to see that the jetties and other conveniences are still incomplete, but they will no doubt be finished and added to as increase of traffic requires:—"It is satisfactory to note that quick dispatch is being given in the loading and discharging of steamers on the opened section of the Ship Canal. The steamship Lotus commenced loading salt at Weaver Pool on Friday afternoon last, and her cargo of 702 tons was all loaded and stowed on Saturday night. The steamship Topaz entered the Canal on Monday afternoon and discharged 590 tons of cement before noon yesterday—Tuesday. Although the loading facilities are only supposed to come into operation from July 1st, and although the jetties and wharves now being constructed at Weaver Pool are not quite ready, shipowners have found out the advantages of the opened section of the Ship Canal, and the following steamers are either in the canal now or due within the next day or two:—Steamship Lucien 630 tons, steamship Dundonald 550 tons, steamship Millicent 800 tons, steamship Burnock 500 tons, steamship Ituna 450 tons, the last four being chartered to load salt at Weaver Pool, all of them vessels which are unable to reach Upper Mersey ports. The company have issued a schedule of the dues, tolls, and charges payable upon traffic using the Canal between the entrance at Eastham and the Weaver Pool."

The entire traffic of the Bridgewater and Weaver systems, as well as of the Shropshire Union Canals from Ellesmere Port, amounting in the aggregate to about 4,000,000 tons per annum, is now using the lower section of the Manchester Ship Canal, and passing to and from the Mersey by the Eastham Locks. A line of passenger steamers ply daily between Northwich and Liverpool, and electric launches are also running for the convenience of the public.

The completion of the Canal will, no doubt, take place at a date long after that which was at first proposed, but with proper management a large part of the Canal will be in profitable use some considerable time before the completion of the whole.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

ANNUAL CONVENTION, 1892.

OUR American correspondent sends us the following account of the annual convention of the American Society of Civil Engineers, which was held in June at the Hygeia Hotel, an immense winter and summer resort, at Old Point Comfort, Virginia. This place is situated at the lower end of Chesapeake Bay, facing the opening to the Atlantic Ocean, between Cape Henry and Cape Charles. It is about 333 miles south of New York, and the most direct route thence is by the Pennsylvania Railway, going through Philadelphia, and then running along the peninsula to Cape Charles, whence a large steamer ferries passengers across the bay to Old Point Comfort and "The Hygeia." A special train carrying members from eastern points left New York, 8.45 a.m., June 7th, and connected with the steamer, which landed them at the hotel about 7.30 p.m. About 150 members and 50 guests were present, among the former being several of the specially distinguished men of the profession, including General George S. Greene, who is now 92 years of age, but active and hearty. Close to the hotel grounds is Fort Monroe, one of the largest of the coast defences. Here, on June 8th, there was a parade and review of the five batteries forming the garrison, and the artillery school was also visited. Guard mounting, drill, dress parade, &c., were also visited on the different days of the convention, and on June 10th there was target practice with an 8in. rifle and a 15in. Rodman smooth bore, of the now antiquated type which did such effectual service during the Civil War. The neighbourhood is rich in memories of that "late unpleasantness." At the south-west end of the bay is Hampton Roads, where was fought the memorable duel between Captain Ericsson's Monitor—"the cheese-box on a raft," as she was called—and the impregnable ironclad Merrimac, with a victory for the former. Opening into Hampton Roads is the mouth of the James River, at the head of which is Richmond, which was so long besieged by the Northern and held by the Southern armies.

At the session on June 8th, the following papers were read:—"Uniform Practice in Pile Driving," by Mr. J. Foster Crowell; "Iron Wharf at Fort Monroe, Va.," by Mr. J. B. Duncklee; "The Iron Coal Pier of the Norfolk and Western Railroad at Norfolk, Va.," by Mr. W. W. Coe; "Rainfall, Flow of Streams, and Storage," by Mr. Desmond FitzGerald. After the afternoon session the Society viewed the parade above referred to, and in the evening the President, Mr. Mendes Cohen, delivered the annual address, taking for his subject the early history and development of the Baltimore and Ohio Railroad. Mr. Cohen is a native of—born in 1831—and resident in Baltimore, Md., and was connected with the early days of what is now the great Baltimore and Ohio Railroad system. In 1851 he was appointed assistant engineer under Mr. Ben. D. Frost, who had charge of the famous 6 per cent. temporary track over the Broad Tree Tunnel, whose heavy grades and curves of 300ft. radius were then absolutely without precedent, and excited astonishment and interest throughout the world. After this work was completed Mr. Cohen was transferred to the motive power department, holding a position corresponding to that of an assistant superintendent of motive power. Two important duties assigned to him in this position were the adaptation of the wood-burning passenger engines to coal burning, and the handling of traffic on the famous 10 per cent. temporary grades over the Kingwood Tunnel, which still remains a remarkable and exceptional performance in railway records.

On June 9th there was an excursion by steamer to the United States Navy Yard at Portsmouth, across the bay, and the neighbouring city of Norfolk, a large seaport, and the tidewater terminus of the Norfolk and Western Railway. From Norfolk a narrow-gauge railway, eighteen miles long, took the party to the Princess Anne Hotel at Virginia Beach, an isolated summer hotel and resort on the open Atlantic coast, where lunch was served. On June 10th there was a business meeting in the morning, at which the announcement was made that the Society has, by request, undertaken the management of the Civil Engineering Section of the Engineering Congress to be held at Chicago in 1893. At the afternoon session papers were read as follows:—"Hardening Structural Steel," by Mr. A. C. Cunningham; "Results Obtained from Tests of Full-sized Steel Eye Bars," by Mr. F. H. Lewis; "Experiments on Iron and Steel Joints Rivetted at an Angle," by Mr. B. B. Flint; "Baltimore and Ohio Railway Tunnel in Philadelphia," by Mr. W. W. Thayer. Mr. Dagron described the lining of an iron-covered tunnel in Baltimore with firebrick, on account of the corrosion due to smoke and gas from the engines. In the evening Mr. A. Fteley, Chief Engineer of the Aqueduct Commission, New York, gave a description of the New Croton Aqueduct, illustrating his lecture by the stereopticon.

On June 11th progress reports were presented by the committees on "Impurities of Domestic Water Supply;" on "Uniform Methods of Testing Materials used in Metallic Structures;" and on "Standard Rail Sections." There was also a visit to the extensive shipbuilding yards, machine shops, and timber dry dock of the Newport News Shipbuilding Dry Dock Company, at Newport News, Virginia, near Old Point Comfort. The following are brief abstracts or notices of the most important papers presented.

Uniform Practice in Pile Driving, by Mr. J. Foster Crowell.—The best known formulas for the bearing power of piles were given, with a diagram illustrating the variation in a particular case of the results given by sixteen formulas both as to extreme sustaining power and permissible load. These variations arise from the different methods of treating the problem, some authors taking into consideration the compressibility and weight of pile, others neglect one or both. The formula most favourably considered was:

$$L = \frac{2wh}{s + c}$$

but the author suggested a change in this, making the constant (c) a "tangible variable for natural conditions and a selective variable according to the requirements of the case." This variable to be for three conditions, as follows: (1) Where the load is static and known, but the natural support for the piles is insecure and doubtful: (2) where the support is trustworthy, but the load is dynamic; (3) where the support is not known and the load is dynamic.

Iron Pile Wharf at Fort Monroe, Va., by Mr. J. B. Duncklee.—This wharf runs from in front of the Hygeia Hotel to 20ft. depth of water, and is used for a steamboat landing. It is built on hollow cylindrical cast iron disc and screw piles, spaced 14ft. apart, centre to centre, in each direction. There is an upper and a lower system of horizontal bracing, of steel and wrought iron. The floor beams are steel I-beams, and the joists and planking are of Georgia pine. The area covered is about 63,500 square feet, and the floor is 7ft. 11in. above low tide. The wharf extends to a depth at low tide of 20ft. The extreme length is 332ft., and the width of the outer edge is 254ft., narrowing shoreward to 56ft. The disc piles are used from the shore to 10ft. depth of water, beyond which are the screw piles. The discs were 3ft. in diameter and 1½in. thick, and the piles were sunk about 6ft. in the sand by the use of a 2in. water jet. The floor beams were secured to flanges or caps at the top. The screw piles were each set over a creosoted wooden bearing pile, driven by a 2200 lb. hammer falling 15ft. to a penetration of 1in. at the last blow. They were then cut off about 4ft. above the sand, and the iron piles were screwed down over them until the wooden piles were covered at least 8ft. by the iron pile, when the middle section of the latter took a bearing on the top of the former. The hollow piles were then filled with concrete.

Iron Coal Pier of the Norfolk and Western Railroad at Norfolk, Va. By Mr. W. W. Coe.—The pier extends 805ft. and is approached by a single track. There are two delivery tracks, one on each side of the pier, having a descending grade from the summit of 9in. per 100ft. There is a gravity return track between the delivery track with a grade of 2½ per 100ft. Transfers from the delivery to the return tracks are made by two shifting tables with an end movement of 8ft. overcoming a grade of 8in. After these tables receive the empty cars they move by gravity to the line and grade of the return track, and the car runs down the latter. A counterbalance then brings the transfer back to place. The foundations of the pier consist of hollow iron piles in bents 36ft. apart, four piles in each. These piles are 12in. diameter, ½in. thick, built with flush joints in sections 14ft. to 20ft. long. There is a cast iron disc 4ft. in diameter at the base of each. The total length of the piles was 45ft. to 57ft., and the pressure of water used in the jet for sinking was 30 lb. to 60 lb. per square inch.

Rainfall, Flow of Streams and Storage. By Mr. Desmond FitzGerald.—This paper referred to the water supply and watersheds of Boston, Mass., and gave a series of tables which were prepared for the purpose of calculating the yield of drainage areas which have varying proportions of land and water surface. The average yearly rainfall at Boston for seventy-four years is 47in. with an annual range of from 27·70in. to 67·73in. The monthly rainfall showed a minimum of 0·23in., and a maximum of 12in. From 45 to 50 per cent. of the rainfall flows away in the streams, and about 50 per cent. is evaporated from the ground and other surfaces. The maximum monthly yield from the Sudbury watershed was 7·448 cubic feet per second per square mile, or about a hundred times minimum monthly yield. The maximum for twenty-four hours was 41·4 cubic feet per second per square mile. The minimum monthly yield was 0·068 second-feet per square mile. The average daily yield was 1·5472 second-feet per square mile.

Hardening Structural Steel. By Mr. A. C. Cunningham.—The present method of making the heads of eye-bars, with the upsetting, hammering, and partial heating of the bar, leaves the steel in an uncertain condition as to internal stress, which can only be remedied by annealing, and various tests have been made by quenching from a cherry-red heat in water, fish-oil, soap and water, and boiling water. The oil gives the best results. The hardening of steel in compression members is as important as in eye-bars.

Tests of Full-sized Steel Eye-bars. By Mr. F. H. Lewis.—In these tests the author found differences as great as 5000 to 10,000 lb. per square inch between the tested strength of full-sized steel eye-bars and of small specimen tests of the same material, together with a notable decrease in the full-sized bars in elastic limit. The average loss in elastic limit is 1142 lb., and ultimate strength 3595 lb. The reduction in area is somewhat greater in the specimen tests; and the stretch in 8in., as compared with that on the gauged length of the bars, was nearly double. The author commented on the irregularities in the tests for elastic limit, which make it impossible to put them in a line or curve. He showed that large losses occur generally in bars giving high specimen tests, but that bars of 60,000 to 64,000 lb. ultimate strength show average losses of only 765 lb. per square inch. His conclusions were:—First, that we have only to use steel with low tensile strength and the large losses will disappear. Secondly, that tests which give high figures in specimen tests are less trustworthy than those which give low ones, and do not represent the mean value of the material. Engineers are deceived by these high values, and no doubt the real quality of any material is shown by the mean results. He next treated of the losses in elastic limit and ultimate strength by annealing, the effect being chiefly in softening the outer skin. These losses are, however, legitimate, and should be provided for in the specifications.

Experiments on Iron and Steel Joints Rivetted at an Angle. By Mr. B. B. Flint.—Experiments were made on lattice bars of various dimensions, rivetted in various ways to a 6in. by ½in. iron plate. The breaking load varied between the limits of 45,800 lb. to 55,660 lb. per square inch of net section. In some cases the rivets sheared, in others the plate broke between the rivet holes. The specimens with reamed holes were in general the stronger. The strength per square inch of the lattice bar increased as the angle made by the line of rivets with the bar increased. The strength of the joint as a whole for the same number of rivets was but little affected by the position of the holes.

Emergencies on Railways. By Mr. C. M. Bolton.—This subject, referring specially to wrecks and accidents, was divided into three parts:—(1) The removal of the wreck of a train when the track is obstructed; (2) the removal of the wreck caused by the failure of a bridge, and the erection of a temporary trestle; (3) a list of tools and appliances which every railway company should have on hand at a convenient point on its line, ready for use when emergencies arise.

Black Eagle Falls Dam at Great Falls, Montana. By Mr. M. S. Parker.—The Missouri River at Great Falls has, from the first rapid to the foot of the falls, a distance of 10 miles, a descent of 412½ft., and 75½ft. of this is a "sheer drop" at the Great Falls. The minimum flow of the stream is 4000 cubic feet per second, except when the flow is affected by anchor ice. The dam is just above the Black Eagle Falls, and gives 40ft. head of water for power. It was completed in 1891, and is built of timber cribs filled with stone partly laid in cement, and the chief difficulty to be overcome was the rapid current, due to a fall of about 2 per cent. at the site. The cost of construction was 175,000 dols. Assuming 3360 cubic feet as the minimum flow, there would be available 12,287-horse power, and the cost would therefore be 13·19 dols. per horse-power.

Bridging Cañons Lengthwise. By Mr. H. V. Hinckley.—This paper described one case of a bridge crossing a cañon diagonally, and another of a bridge parallel with the cañon and crossing the opening of a lateral cañon. The first is in the Apache cañon, New Mexico, on the Atchison, Topeka, and Sante Fé Railway, and is a deck girder structure, with the middle supported on two "legs" sloping downward in bearing, one on each side of the cañon. The second is in the Royal Gorge, on the Denver and Rio Grande Railway, where the inner ends of the floor beams are secured to a ledge of the rock, while the outer ends are carried by a plate girder, hung from the apexes of two pairs of inclined beams, which rise from footings on the rocks of the opposite sides of the cañon to the point of intersection above the girder.

Cantilever Highway Bridge at Cincinnati, O. By Mr. G. Kaufman, and the *Cantilever Span of the Bridge.* By Mr. F. C. Osborn.—This bridge was built during 1890 and 1891. Its total length is 2966ft., and the main cantilever span is 520ft. c. to c. of pins. The roadway is 24ft. wide, and there are two side walks, each 7ft. wide. The channel span has a clear height of 100ft. above low water, and 40ft. above high water. The site was very favourable for building upon, as rock foundation was found at very moderate depths. The work was greatly impeded by the great number of floods of those years. In the design of the cantilever span, the intention was to eliminate, as far as possible, all undulatory and vibratory motion from passing loads; rivetting connections being for this reason made large use of. The question of appearance as affecting the design was considered, and the elements governing the calculation of camber are given. The anchorage strain was calculated at 136,000 lb. for each truss, and is taken up by a 6in. by 1½in. eye-bar anchored in 20ft. of masonary. Provisions were also made for alternating strains in the top chord of the anchorage arm.

Other papers on the list were, "Foundations," by Mr. A. P. Boller;" "Thin Floors for Bridges," by Mr. A. F. Robinson; "Motive Power for Street Railways," by Mr. A. F. Sears; "Power Required to Drive Electric Street Cars," by Mr. L. B. Burnett; and "Economics in Railway Tie (Sleeper) Renewals," by Mr. B. Reece.

THE MILLING EXHIBITION.

THE most prominent exhibit is perhaps the complete one-rack roller mill plant by Messrs. Armfield and Co., of the Vale of Avon Ironworks, Ringwood, Hants. The plant is erected in a wooden frame building with three floors, and is driven by a 6-horse power under-type engine of Robey's make. The whole is very neatly arranged, and all the machines are driven from two shafts, a first-motion shaft below driving the roller mills, and one shaft above the top floor driven from the first-motion shaft, the upper one driving elevators and other machines. There are six pairs of rolls, two pairs in one frame on the first-floor. The rolls are 6in. diameter, 12in. long, the first and second break in one frame. The third break, which, in this small plant with only three breaks and three reductions, serves as bran rolls, are in the same frame with the second reduction. The first and third reduction are in the remaining frame. All the rolls are in pairs horizontally side by side, and have automatic feed regulation to the reduction rolls. The automatic feed regulation seems to be held as of importance by English makers, but the continental roller mills at this exhibition have nothing of the kind fitted to them. On the second floor there is one double purifier, fitted with trays for catching some of the light particles of floury matter which are carried up by the wind. These trays, about which much ingenuity has been expended during the last few years, are arranged close down to the silk sieves, and by breaking up the current of wind, and causing small areas of calm, allow certain valuable particles to fall back into the trays which would otherwise be either carried away into the stive room, or possibly some would fall back on the sieve and go away with the purified middlings, and thus on one hand cause loss, and on the other render the purification incomplete.

The three centrifugals are iron framed, with boarded hoppers, and are belt-driven at a speed of 260 revolutions per minute; the silk of the centrifugals is kept clean by a revolving brush. The chop reel is three sheets long, and is on the top floor with the centrifugals and the bran duster. The scalping is effected in a double rotary sieve scalper, driven by a vertical shaft and cranks. The bran duster is one of Armfield's horizontal adjustable pattern, of which Fig. 1 shows a sectional view; the frame is of iron with boarded top and hoppers, and in outside appearance is uniform in shape with the centrifugals. The cylinder is a light conical revolving iron cage, with steel ribs so disposed as to form a spiral trough inside the cover. The drum is a series of brushes on a quick revolving shaft, provided with a worm at both ends by which the feed is taken in and the tails discharged just below the shaft level. Being conical in form and movable endways, it admits of more or less severe action of the brushes on the goods by a simple adjustment whilst the machine is moving. The wire covering is laced on the outside of the cylinder. An adjustable outside brush is provided for keeping the wire covering clean. The sizes of these machines varies from 1480 square inches of surface up to 5020 square inches, and the capacity from approximately 200 lb. to 1000 lb. per hour, the speed of the drum from 550 in the smallest size to 400 in the largest sizes. Messrs. Armfield state they are working at the exhibition on a mixture of half English and half foreign wheats, producing about 70 per cent. of straight grade flour, the bran weighing about 11 lb. per bushel, the pollard about 27 lb. per bushel, and that the engine indicated 9½-horse power, the cost of the plant, exclusive of the engine, being about £600. The plant works very steadily and quietly, and, of course, includes the necessary elevators, corn bins, and magnetic separator in the corn spout, and a smutter of Howes and Ewell's make.

Amongst the roller mills, those by Israel Bros., of Dresden, claim some attention. They are arranged in the "three-high" method, with the centre roll spindle running in fixed bearings, the outer rolls adjustable by levers and springs. These two rolls have adjustments, so that either may be set independently of the other. Three-high roller mills are not now much in fashion in this country, the number made at the present time having greatly decreased in the last six or seven years. Messrs. Israel also show a pair of first and second break rolls in a massive cast iron frame for maize grinding, arranged in pairs horizontally. The doors in this mill are provided with ventilating shutters neatly arranged. Another example by the same firm is a two-roller mill in a frame cast in one piece, and a very complicated casting it is. There is an arrangement for throwing out the rolls should the feed fail, at the same time setting an alarm bell ringing. The throwing-out gear consists of a lever with a heavy weight

hell up by a catch; when the feed fails, the catch lets the lever go and the weight falls some distance on to a knob at the end of a vertical rod connected to the lever by which removable in a very simple manner. The machine is driven by fast and loose pulley, and a two-step pulley is used for driving the fan, so that two different speeds may be attained.

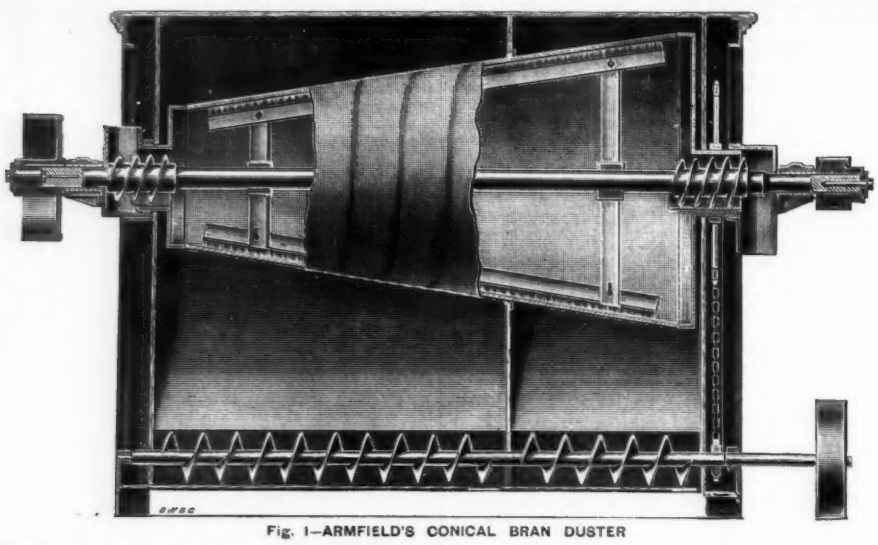


Fig. 1—ARMFIELD'S CONICAL BRAN DUSTER

pressure is put on, and throws the pressure off the rolls which then run out of contact—a good point in the case of fluted rolls especially. The hoppers of these mills have a stirrer to keep the feed from hanging up, but they have no automatically adjusted feed regulation now often used. Fig. 2 shows a perspective outside view of a mill with one pair of rolls arranged side by side horizontally.

Mr. Charles Hopkinson, of Retford, exhibits six examples of his well-known roller mills, one of which has some special points worthy of notice, amongst which are a very simple and neat automatic feed regulator; this, as we have before remarked, seems to be held as essential by English millers. One hand lever to each pair of rolls, which on being moved over separates the rolls and puts the feed roll out of gear, thus stopping the feed. The general design of the mill is substantial, and all working parts can be readily got at. There is a hand lever which when moved over to relieve the pressure comes in contact with a second lever, and throws the feed roll clutch out of gear. A hand wheel in front is used for adjusting the pressure; besides these a separate adjustment is provided for each end of the roll, in order to obtain an even sample.

A well-designed double middlings purifier is also shown at this stand, and has many points of interest, showing how middlings purifiers have developed in small details whilst the principle remains the same, viz., that of purifying middlings on a sieve through which a current of air is drawn by means of a fan. The small details alluded to are now matters of great importance, especial attention being given to preventing

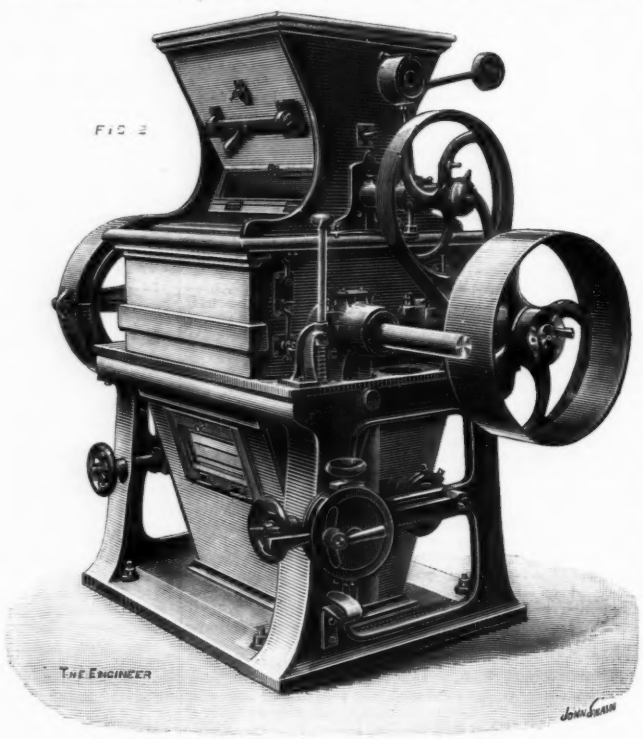


Fig. 2—ISRAEL'S FIRST AND SECOND BRAKE ROLLS

Over the silk a slotted corrugated plate is fixed to catch the fluffy particles. These are delivered at the tail end of the machine. The air or suction box at the top of the machine is hoppered inwards to the centre and provided with a worm, which delivers any portions of stive that may settle in the air space. The air is regulated in the usual manner with valves. The main working parts are fixed to an iron frame

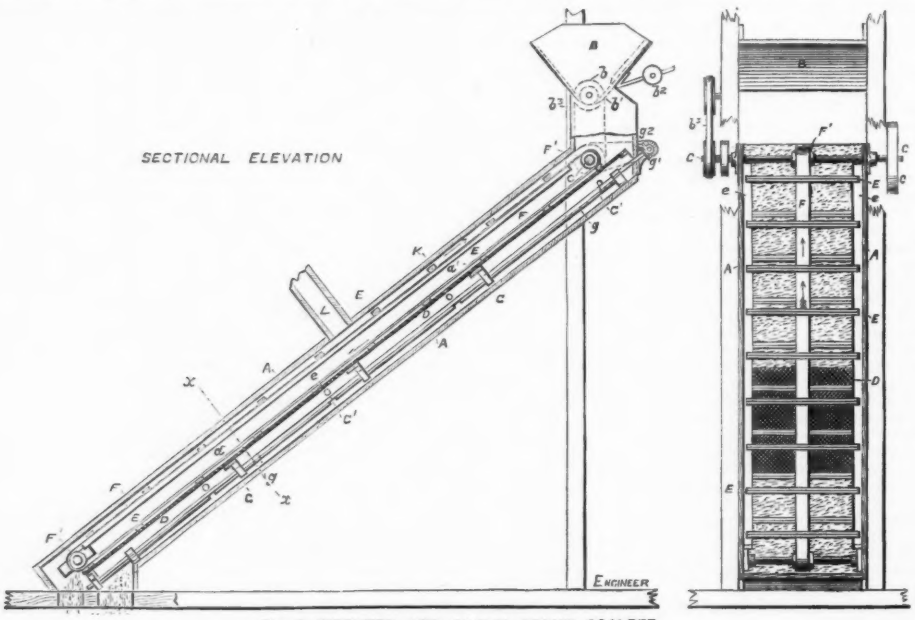


Fig. 3—FIECHTER AND BATES' SPOUT SCALPER

valuable particles being carried away into the stive-room. Means are provided for getting at the worm conveyors and the working parts by portions of the woodwork being made

of the pattern which Mr. Hopkinson has used for some years. This machine is fitted with the automatic feed regulator of the same kind as those on the roller mills.

Mr. Hopkinson also exhibits other examples of his well-known machines, a small double centrifugal for one-sack plants is arranged with two separate deliveries from each end to the centre, so that the beaters are for both reels on one spindle, the machine being double lengthways, not as usually the case, double side by side with two spindles, and being driven by two belts, so that the new machine takes less room and only requires one belt to drive it.

A rotary scalper containing four scalping sieves in one chest, designed to scalp from four breaks, has certainly a very massive frame; it is driven by belt on to a pulley on the vertical shaft, and is for small plants. At this stand there is a good collection of chilled rolls, one 30in. diameter for seed crushing; others, both fluted and plain, for flour milling of the usual sizes, and pieces of broken rolls to show the depth of the chill.

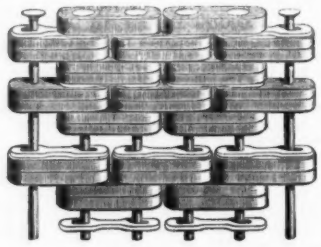
Messrs. Emil Fiechter, of Liverpool, exhibit some of Messrs. C. O. Dost and Co.'s roller mills, one a two-high mill and the other a single-pair horizontal mill, with rolls 30in. long by 9in. diameter; the former fitted with an arrangement for stopping the feed roll when the hopper is empty by means of a falling weight held up by a catch, which disengages when the hopper is empty, and knocks out the clutch on the feed roll spindle.

Messrs. Fiechter also exhibit a Bates patent spout scalper, which, as its name implies, is of a spout-like form, and is stated to occupy very little room, and effect a thorough scalping by means of an arrangement shown in Fig. 3, and described as follows:—A is a shoot or spout, into one end of which the material to be separated is fed from a hopper B, and along which such material is caused to travel. The hopper B is provided with an adjustable counterbalanced feeding device. The size, form, and inclination of the shute depend to a large extent upon the nature of the material under treatment. The shute or spout scalper is provided with a false bottom of perforated metal sheet, wire, or silk gauze, and is divided into two or more frames in order to facilitate the removal of the sieving surface. The flow and distribution of the material under treatment is regulated by an arrangement of bars E of wood, leather, india-rubber, or other suitable material, but preferably of wood. These bars are fixed to, and arranged in a more or less transverse position upon an endless travelling band, which is mounted upon pulleys in such manner that the bars E are caused to travel successively along the shute in proximity to the sieving surface. The speed of this band is regulated according to the requirements of each case, so that the movement of the bars—E—either retards or assists the progress of the material down the shute. The action of the bars E also serves to distribute the material evenly over the sieving surface to produce a better separation of the material, and to keep open the perforations or meshes of the sieves. A rapid rocking or shaking motion is imparted to the sieve sections which helps to keep the meshes or holes of the sieving surface open and clear, and by this shaking action any loose material will become separated from the bran and fall through the sieves, so that the overtails passing into the next break roll are well scalped and free from semolina and middlings.

Herr Grusen, of Magdeburg, represented in London by Mr. W. Stamm, exhibits some of the celebrated Gruson chilled rolls, a ball mill, and other articles.

GASKING'S STEEL AND LEATHER LINK BELT.

The engraving below represents a piece of Gasking's leather-link belt with intermediate steel links, with long slotted holes, which permit a moderate extension of the leather links before the steel links take up the work. The belt then runs as a leather-link belt, reinforced by the stronger and less extensible steel link. The softness of the



leather upon the pulleys is retained, a somewhat lesser weight of leather is used, and great strength is obtained. The belt is used for very heavy work such as brick, machinery, deal frames, elevator bands, and outdoor work, and is spoken of by users in very high terms. Although fitted with steel links the elastic flexibility of the leather is sufficient to enable it to continue to take up some of the tensile pull and to run softly. It is made by the Gasking Driving Belt Company, Enfield.

Some Large Wire Ropes.—Two large consignments of wire ropes and pulleys have just been sent from Messrs. George Elliot and Company's works at Cardiff, amounting to over 100 tons. These ropes were made upon the patent locked coil principle of which Messrs. George Elliot and Company are the sole manufacturers in this country, and the greater portion of these consignments were sent away from Cardiff for shipment at the Alexandra Docks at Newport, Mon., travelling over the Pontypridd and Caerphilly Railway, in which Sir George Elliot is largely interested. One consignment alone occupied ten trucks, and one of the ropes measured 25,500ft. in one continuous length. This locked coil construction of rope has several important advantages, amongst which is that it does not twist, for it is not made of strands laid together, but of layers of wire placed one over the other, and so locked into position, that although the outer surface of the rope is smooth and round, the rope is extremely flexible, and the wires are locked together in such a manner that in the event of one of the wires breaking it is held in its position, and does not come out of place. This smooth surface is not only advantageous by reason of the rope not twisting as a stranded rope does, but also by greatly saving the wear of the pulleys, which is an important consideration, especially where the ropes have to be used abroad; and this patent construction, which naturally met with much opposition when it was first introduced by Sir George Elliot some years ago, has so commended itself to users, both in England and abroad, that the very largely increased demand for it has necessitated extensive additions to the special machinery used in its manufacture.

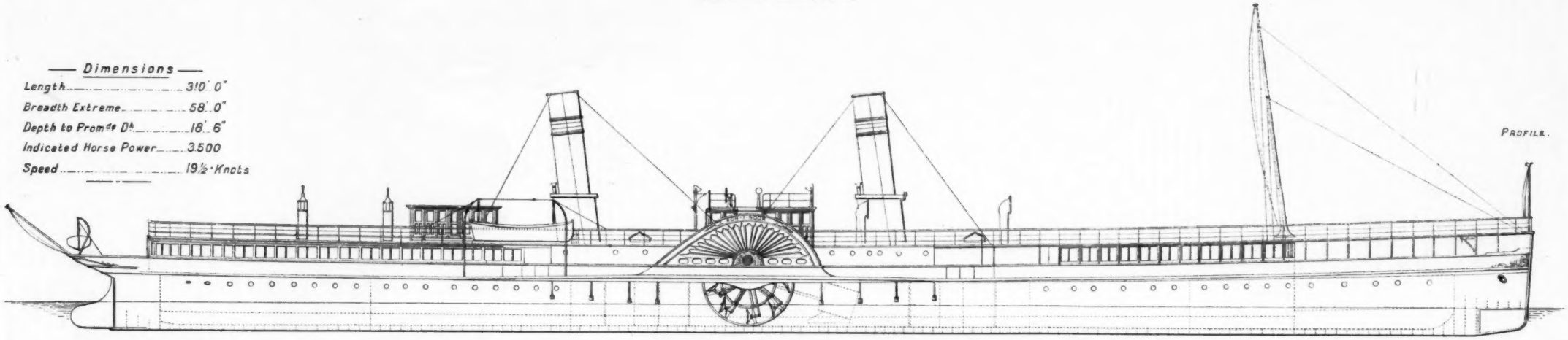
THE RIVER THAMES STEAMER KOH-I-NOOR

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, GOVAN, BUILDERS

(*For description see page* 40)

— Dimensions —

Length	310' 0"
Breadth Extreme	58' 0"
Depth to Prom^de D^k	16' 6"
Indicated Horse Power	3500
Speed	19½ Knots



The Engineer. John Strain. Engr.

COMBINED SHIP LIGHTING ENGINE AND DYNAMO

MESSRS. CHARLESWORTH, HALL AND CO., OLDHAM, ENGINEERS

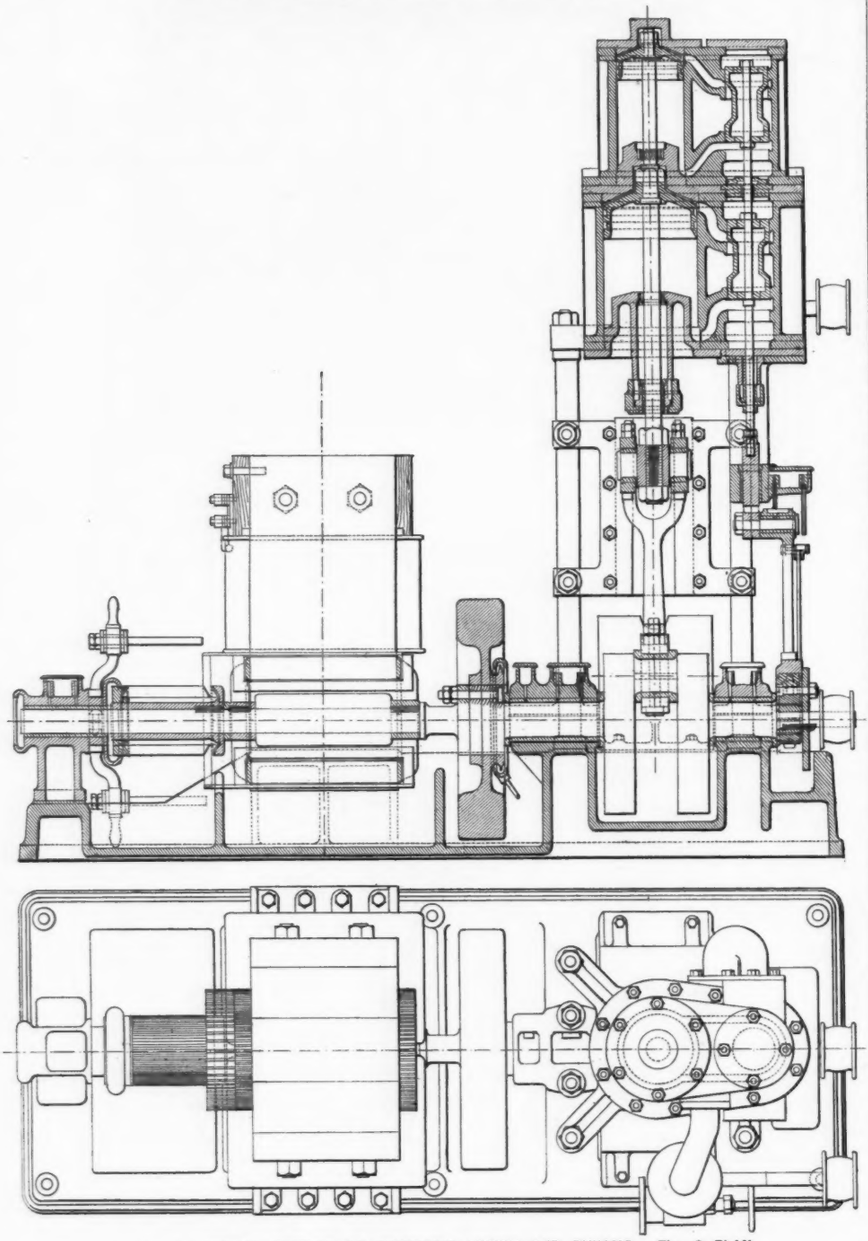


Fig. 2—VERTICAL SECTION OF COMPOUND ENGINE AND DYNAMO—Fig. 3—PLAN

ENGINES AT THE CRYSTAL PALACE.

AMONGST the engines exhibited at the Crystal Palace exhibition were several by Messrs. Charlesworth, Hall, and Company, of Oldham, some of which we now illustrate. One is an open-frame single-crank compound engine, as illustrated by Fig. 1, the two cylinders being superposed. The piston-rod is common to both cylinders, which are respectively of 4in. and 5·5in. diameter, with a stroke of 4·75in. A Pickering governor is employed, and the engine is coupled direct to a Hall dynamo, which it drives at 540 revolutions per minute, at which speed it worked very smoothly. The dynamo has a Gramme armature 8in. diameter, 8·25in. in length, wound with 320 convolutions of No. 1, 10s B.W.G. wire, the resistance being 0·076 ohm. The armature weighs 191 lb., and is fitted with a commutator having eighty bars of hard-drawn copper insulated with mica. The magnets are compound wound, the shunt coils having a resistance of 30·62 ohms. The series coils consist of two layers on each leg of cable No. 19, 16s B.W.G., having a resistance of 0·0327 ohms. Thus the electrical efficiency from these figures, supplied us by Messrs. Charlesworth, Hall, and Company, is 84·53 per cent., the armature loss being 8·72 per cent., loss in magnet shunt 3·01, and in magnet series coils 3·74 per cent.

At 540 revolutions per minute, the machine gives 75 ampères at 65 volts. The engine attracted a good deal of attention, although it occupied a very small space. The frame consists of steel pillars fastened by nuts under the bed-plates, and carying a casting which is fitted with crosshead guides. The cylinders are provided with piston valves ground in, and the pistons are of aluminium steel fitted with cast iron rings. The same steel is used for the connecting rod and crosshead, and the crank is of forged steel with the balance weights forged on. The engine, it should be said, is single-acting. A metallic packing is used between the two cylinders. Very complete lubrication is provided by means of an oil-box and pipes, and the workmanship throughout is good.

Our engravings Figs. 2 and 3 show the arrangement of a similar but larger engine with dynamo as made for ship lighting. Most of the description given of the smaller engine applies, it will be seen, to this. The cylinders are 6·5in. and 9in. respectively, with an 8in. stroke. The engine, like the foregoing, is single crank, and runs at 380 revolutions per minute. The sectional engraving shows the arrangement of the piston valves, which like the pistons are on one rod, with a metallic packing between the two steam chests. A very long stuffing-box is used for the piston-rod, and the gland is screwed up by an exterior nut, which prevents the uneven screwing up common with ordinary glands. Very large bearing surfaces are used, and the crank bearings are close up to the crank dips. The engine is coupled direct to a Hall's dynamo, having a Gramme armature 12in. diameter, 14in. in length, and built up with 160 copper bars. Its resistance is 0·0161 ohm, and it weighs complete 552 lb. The 80 commutator bars are, as in the smaller machine, insulated with mica. The magnets are compound wound, the shunt coils having a resistance of 19·67 ohms. The series coils consist of one layer of eight turns on each leg of two cables of No. 19 12 strand, B.W.G. in parallel, and having a resistance of 0·00184 ohm. The loss in the armature, the makers state, is 6·28 per cent., in the magnet shunt 1·123 per cent., and in magnet series winding 0·718, or a total of 8·119 per cent., leaving an electrical efficiency of 91·88 per cent.

MANCHESTER ASSOCIATION OF ENGINEERS.

THE SHIP CANAL.

THE annual summer excursion of the members of the Manchester Association of Engineers took place on Saturday, when a very numerous party of members and friends were conveyed by special steamers along the Weaver Navigation from Northwich to the junction with the Manchester Ship Canal, thence on to Eastham through the locks, into the Mersey, and finally landed at Liverpool. The excursion was of special interest, as it enabled the party to inspect the completed portion of the Manchester Ship Canal, and to form some idea of the traffic which is already being developed. The original scheme for the construction of the canal, it may be here noticed, would not have directly opened up the canal to the Weaver Navigation; but the revised scheme which has been forced upon the promoters, although a more costly undertaking, will to a large extent compensate for the increased outlay by the important trade which will find its way into the canal from the large salt and chemical works at Northwich. The journey along the Weaver Navigation occupied about a couple of hours, and was much enjoyed, but the chief interest was after entering the Weaver pool, where right across could be seen the already famous Weaver sluices, the work in connection with which was began early in the history of the Ship Canal Company, and which were completed and ready for use at the beginning of last year. Having crossed the pool, the steamer passed through a narrow gap, bridged for traffic purposes by a temporary swing bridge; but when the canal is sufficiently completed, the bank which at present divides the river pool from the ship canal will be removed, and there will be an imposing bell-mouth entrance to the pool. Immediately after passing the gap, a wharf was seen in course of construction, which will consist of a jetty, alongside which large vessels can be moored in the canal, and their contents unloaded and loaded again into smaller boats, in shallower water on the other side of the jetty. It is believed that this portion of the canal will in the future be a centre of active work, and already a considerable amount of traffic is being dealt with. Although the loading facilities were only supposed to come into operation from July 1st, and the jetties and wharves now being constructed at Weaver Pool are not yet quite ready, quick dispatch is already being given in the loading and discharging of steamers, a number of vessels ranging from 450 up to 800 tons, which otherwise could not have reached the Upper Mersey ports, having been loaded with salt at the Weaver Pool, and the Millicent, a vessel of 1100 tons, with fishery salt for the East Coast of Scotland, was last week loaded up within twenty-four hours — this steamer being the largest vessel which, up to the present date, has entered the canal. The company have, in connection with this traffic between the entrance at Eastham and the Weaver Pool, now issued a schedule of dues, tolls, and charges, in a note to which they point out that the opening of the Ship Canal to the river Weaver enables vessels of large tonnage to reach the upper Mersey, whilst it also enables small sea-going vessels to reach the upper Mersey ports upon all tides, instead of only at spring tides, as hitherto. Trans-shipments can now be effected between ocean-going vessels and narrow canal boats, thus avoiding the second trans-shipment and consequent additional handling hitherto necessary upon over-sea and canal-bound traffic to and from Staffordshire and the Midlands. The timber trade of the district, it is added, is for the first time accommodated with floating stores, and the timber discharged in the canal can be stored afloat or on land, and sent forward either by canal or by rail. Mr. Marshall Stevens, the manager of the Ship Canal Company, who joined the party during the excursion, stated that the contracts for the whole of the remaining unfinished portions of the canal have now been let, and are to be completed by the 30th of June next, so that there is every probability of the canal being open for traffic throughout its entire length towards the close of 1893. In the meantime every reasonable facility and assistance is being rendered for traders desirous of using the portions of the navigation now open, either temporarily until the completion of the canal to Manchester, or permanently such traffic as can be best dealt with west of the river Weaver, and arrangements are being made for the allocation of the various trades which will use the Manchester and Salford locks upon the completion of the Ship Canal.

This is somewhat of a digression, and returning to the excursion, the party, after noticing several points of interest along the route, passed through the first rock cutting, and a set of steps on either side point out Ince Ferry, where access can be had from the mainland to the shore; whilst near here stood the old Ince Lighthouse, directly in the way of the canal cutting. Further on, the river Gowy is carried underneath the canal in two steel pipes, each 12ft. in diameter, and through these tubes the tides daily ebb and flow, below the bottom of the canal. The next point of interest was Ellesmere Port, the most interesting feature here being the bank on the right, reclaiming the shore, in the construction of which it is stated that 150,000 piles were driven, these being bolted together with steel bolts 36ft. long, and then buried in rubble and clay. In this bank is placed the second of the tide openings, which, like the one on the Weaver, is 600ft. long, and allows the free commingling of the river and canal waters at high tide. Nearly opposite this point important work is being carried out in connection with the Shropshire Union Railway and Canal Company, including the entire reconstruction of the entrance, and the erection a little further west of a new wall, 900ft. long, at which large vessels have already been unloaded. Passing through the Pool Hall rock cutting, the party entered the Eastham locks. On the left bank of the canal is the hydraulic house, in which is placed the boilers and engines generating the power for moving the immense gates, two of the largest of which weigh 600 tons. Passing through the locks, the party proceeded on to Liverpool.

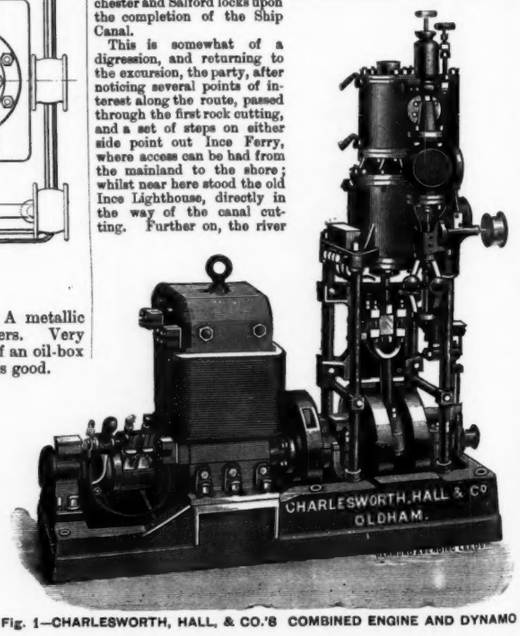


Fig. 1—CHARLESWORTH, HALL, & CO.'S COMBINED ENGINE AND DYNAMO

RAILWAY MATTERS.

THE despatch of goods trains from Baku on the Transcaucasian Railway has been suspended in consequence of the cholera epidemic, and a quarantine of three days established at a station nine miles from Baku for passenger trains. The *Times* Petersburg correspondent says:—It is proposed to sprinkle frequently all the streets of Baku with petroleum as a disinfectant.

THE department of the superintendent of the line, Great Eastern Railway, has issued a pamphlet giving an extensive list of farmhouse and country lodgings in Essex, Hertfordshire, Cambridgeshire, Suffolk and Norfolk, and giving name, address, description of house accommodation, nearest station, and other information useful to those who would like to take a holiday in the country.

IT is stated that Mr. Ketchum has received orders from England to proceed with the work of pumping out the docks of the Chignecto ship railroad, which is generally understood as an order to resume the work of finishing that undertaking. It is said that the water can all be pumped from the docks in three weeks, and if the work of finishing the roadbed and equipping the line is pushed forward at once, it is thought that it can be almost completed before next winter.

ALTHOUGH we understand that Sir Frederick Bramwell has appointed the date for receiving evidence in connection with the purchase by the London County Council of tramways from the London Street Tramways Company, still it is probable that the Leeds case will be settled first, inasmuch as Sir Douglas Galton has appointed an earlier date for receiving the evidence than Sir Frederick Bramwell. Mr. Edward Pritchard, M. Inst., C.E., of Westminster, has been retained by the purchasing parties in each case to give evidence before the arbitrators.

AT the anniversary festival in aid of the Railway Officers and Servants Association, funds for which are urgently needed, it was mentioned that during the year 1890—the last return—upwards of 957,000,000 passengers were conveyed by railways in the United Kingdom, and only 18 were killed and 496 injured from causes beyond their own control; so that in 53,000,000 journeys only 1 person was killed, and in 1,930,935 journeys only 1 passenger was injured. 499 railway servants were killed during the year, and 3122 were injured, out of a total of 346,426.

THE Royal Assent has been given to the Bill for the acquisition by the Cornwall Minerals Railway Company of the Lostwithiel and Fowey Railway. By the purchase of this line of railway of about five miles in length the Cornwall Minerals Railway Company obtains the command of all the available deep-water frontage at the port of Fowey, one of the best natural harbours on the South Coast, and this will add largely to the facilities for dealing with the ever-increasing trade of that port, whence enormous quantities of china-clay are shipped to America and elsewhere.

TWO large locomotives, designed to be of extraordinary speed and power, are nearly finished at the Schenectady Locomotive Works. They will draw the New York and Chicago limited between Philadelphia and Pittsburg. One of the locomotives has eight wheels with cylinders 19in. in diameter and 24in. stroke, and driving wheels 78in. in diameter. The weight of this engine is 123,000 lb., of which about 81,000 lb. is on the driving wheels. The other engine is a two-cylinder compound ten-wheeler, of about 138,000 lb. weight. An American paper says it is expected that this locomotive will take the Pennsylvania limited up the Western slope of the Allegheny Mountains alone, taking the place of two eight-wheel engines now in use.

THE completion is announced of the Central Uruguay Railway from Montevideo to Rivera on the northern frontier, adjoining Brazil, a distance of 352 miles. In 1888, when the northern extension was commenced, the railway only ran to Paso de los Toros, 170 miles from Montevideo, and the intervening section was little more than a wilderness, destitute of communication of any kind and sparsely populated. A vast fertile tract of land, hitherto of little value, is thus opened up to agricultural and commerce. Including only a section ten leagues in width on either side of this extension, an area of 1200 square leagues or 8,000,000 acres is by this enterprise brought within easy communication with the capital and made available for settlement.

THE matter of railway charges continues to be a subject of considerable complaint among makers. Our Birmingham correspondent writes that several of the galvanised iron manufacturers in this district have lately received further notices from the railway companies to the effect that proceedings will be taken unless payment is received without delay of arrears alleged to be due for the carriage of cases in which the sheets are packed. These charges are in some cases heavy, amounting, it is said, to as much as £1000 in some individual instances, and some of the makers concerned are considering the advisability of testing the legal powers of the companies to make back charges of this nature, contending that they are acting *ultra vires*.

THE gross receipts on Russian railways in 1891, exclusive of the Finland and Transcaspian systems, amounted to 285,397,000 roubles, or 10,442 roubles per verst of line—verst = 0·663 mile—open to traffic, compared with 277,110,000 roubles and 10,387 roubles in the preceding year. The number of passengers conveyed in 1891 is given as 40,466,211, compared with 40,062,066, and the weight of goods conveyed as 56,424,760 tons, compared with 55,052,807 tons. While the gross receipts, weight of goods, and number of passengers carried are, in the aggregate, greater than the corresponding figures for any previous year, the gross receipt per verst does not come up to the figures reached in 1888 and 1889, when, owing to the abundant crops of 1887 and 1888, large quantities of grain were transported.

THE following gives some idea of the risk run by the different classes of railway servants, and the number of fatal accidents and injuries in the year 1890:—Of station masters, 1 in 6165 was killed and 1 in 411 injured; of brakesmen and goods guards, 1 in 180 killed and 1 in 14 injured; of permanent-way men, 1 in 347 killed and 1 in 305 injured; of gatekeepers, 1 in 1605 killed and 1 in 321 injured; of engine drivers, 1 in 613 killed and 1 in 36 injured; of porters, 1 in 708 killed and 1 in 88 injured; of shunters, 1 in 174 killed and 1 in 16 injured; of firemen, 1 in 753 killed and 1 in 32 injured; of inspectors, 1 in 879 killed and 1 in 141 injured; of passenger guards, 1 in 738 killed and 1 in 50 injured; of pointsmen and signalmen, 1 in 6337 killed and 1 in 1584 injured; of labourers, 1 in 2011 killed and 1 in 572 injured; of ticket collectors, &c., 1 in 687 killed and 1 in 294 injured; of mechanics, 1 in 6216 killed and 1 in 1998 injured; of other classes, 1 in 413 killed and 1 in 114 injured.

ON the morning of June 15th, the staging traveller and uncompleted iron superstructure of the Covington and Newport, Kentucky, Bridge fell suddenly into the Licking River. Work was being pushed in the distribution and assembling of iron, and the whole force on the structure—variously estimated up to seventy men—was carried down with the mass of iron and timber, and few escaped uninjured. The latest accounts report twenty-two to twenty-five dead, fifteen injured, and four missing. The structure was to serve as a foot-bridge, and over it were to pass the cars of the Belt Line, connecting Covington with Newport and the Highlands. The approach spans had been completed, and the centering pile trestle about 60ft. above the water had been built for the steel channel span 360ft. in length. This was being erected by Messrs. Baird Brothers, of Pittsburg. They had connected up the middle five panels of the superstructure, and had about forty men at work on the large traveller, which rose nearly 100ft. above the staging, when at about half-past ten in the morning the catastrophe occurred.

NOTES AND MEMORANDA.

IN Greater London last week 3375 births and 1747 deaths were registered, corresponding to annual rates of 30·6 and 15·8 per 1000 of the estimated population.

THE deaths registered last week in 33 great towns of England and Wales corresponded to an annual rate of 17·1 per 1000 of their aggregate population, which is estimated at 10,188,449 persons in the middle of this year. The deaths ranged from 9·4 at Brighton to 22·5 per 1000 at Preston.

ACCORDING to a recent statement there are twenty-six jute mills in India having 9181 looms (2175 being broad or over 42in.) and 189,277 spindles. The largest of these is the Baranagore Jute Factory which has 790 looms. The Samnugger Jute Factory comes next with 560 looms, and the Howrah Mills third with 550 looms. It is estimated that these twenty-six mills, in 295 working days, consume raw material equal to 1,564,650 bales of 400 lb. each.

IN London last week, 2489 births and 1377 deaths were registered. Allowing for increase of population, the births were 147 and the deaths 35 below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 17·5, 17·1, and 17·3 in the preceding three weeks, fell last week to 16·8. During the four weeks ending on Saturday last the death-rate averaged 17·2 per 1000, being 0·3 per 1000 below the mean rate in the corresponding periods of the ten years 1882-91.

THE return of the testings at the Gas Testing Stations of gas supplied to the administrative county of London, during the week ending 25th ult., and made under Mr. W. J. Dibdin, F.I.C., shows that the average illuminating power of the gas supplied was equal to about 16·4 standard sperm candles, while the grains of sulphur in 100 cubic feet varied from as low as 8·6 to 15·7, and the grains of ammonia in 100 cubic feet of gas varied from under 0·1 to 0·9; on the other hand, the cannel gas supplied from the Westminster works of the Gas Light and Coke Company gave 21·5 candle power, with 9·5 grains of sulphur and 0·7 grain of ammonia. The smallest observed quantity of sulphur was found in the gas supplied in the St. George-in-the-East district of the Commercial Gas Company, viz., 8·2; and the largest quantity 15·7, in the Plumstead district of the South Metropolitan Gas Company.

A SHORT time ago the following electrolytic experiment was described by Herr Arons to the Berlin Physical Society:—If a hollow copper cylinder be placed between the electrodes of a sulphate of copper voltameter, copper will be deposited on the cylinder where the current enters it and dissolved where it leaves. If the cylinder is free to turn about a horizontal axis, it will commence to rotate as soon as the current passes, owing to the surface next the anode becoming weighted. It is possible to arrange matters so that the specific gravity of the cylinder is only a trifle greater than that of the solution, and hence the pressure of its axis upon the supports may be indefinitely reduced. The containing vessel used by Herr Arons was a glass box. The copper cylinder, which occupied nearly the entire width of the containing vessel, was 4·5 cm. long and 10 cm. in diameter, and the walls were about 1·8 mm. thick. The spindle was formed by a glass rod 1 mm. in diameter, secured to ebonite plugs fixed into the cylinder; the spindle rested on ebonite supports attached to the walls of the containing vessel. The cylinder turned slowly and continuously under the influence of currents varying from 0·1 to 1 ampère. Experiments showed that the speed of rotation was very nearly proportional to the current.

ACCORDING to meteorological observations taken at Cairo from 1868-88 by Dr. J. Hann, the most striking feature in the climate of this part of Egypt is the *Chamsin*, the hot and dust-bearing wind which makes its appearance in March or April for about three to four days at a time, and robs a large portion of the trees of their leaves. The summer winds are from the north, and the air hot, clean, and dry. Towards September humidity appears with the rise of the Nile, the ground is at times covered with heavy dew, and the heat becomes oppressive on account of the moisture. In October and November fog occasionally occurs in the morning, and rain begins to fall. After this season the temperature is uniform and pleasant. Snow is unknown, frost very seldom occurs, and rain is not very frequent. The absolute maximum temperature of the twenty-one years period was 117 deg., in August, 1881, which was also closely approached in May, 1880, viz., 116·4 deg. The absolute minimum was 28·4 deg., in February, 1880, and the mean annual temperature was 70·5 deg. Rainfall is only given for the years 1887-88, in which 0·87in. and 1·67in. fell respectively. The relative humidity sinks at times even on a daily average to 12 per cent., and has been known to fall as low as 3 per cent. at certain hours. Thunderstorms and hail are very rare.

A CURIOUS phenomenon is reported by Mr. E. H. Parker, British Consul at Kiungchow, Hainan, a large island off the southern coast of China, in connection with the tides of that port. The tides inside the inner harbour, he says, require several years of careful observation before they can be tabulated. It appears, however, that there are always two tidal waves a day, though one is so much more considerable than the other that the effect is often practically that of one single tide in the twenty-four hours. The easterly and westerly currents through the straits are not necessarily connected with the rise and fall of the water, either there or in port. The phenomenon of "slack water"—*morte eau*—is also observable every ten days or so at Haiphong, and is probably owing to much the same causes as at Hoihow. At Tourane in Tonquin, too, it is popularly thought that there is usually but one tide within the twenty-four hours. This tide is felt away up to the citadel of Quangnam. In the Gulf of Tonquin the incoming tidal wave flows from the south, a fact which perhaps accounts for the singular circumstance that the westerly current in the Hainan Straits always sets for sixteen hours. One at least of the tidal waves from the east which pass Hoihow cannot get through the straits to Tonquin so soon as that portion of the same wave which takes a circuitous course by way of Annam.

AT a recent meeting of the Paris Academy of Sciences, a paper was read on the sanitary system adopted by the Venice Conference to prevent cholera from penetrating into Europe through the Isthmus of Suez, by M. P. Brouardel. Four previous conferences for the reform of the quarantine system having failed, that convened at Venice in January, 1892, has at last adopted a system chiefly advocated by the French delegates, and practically tested on the Pyrenees frontier during the cholera in Spain two years ago. On that occasion the passengers' linen was disinfected in heating ovens by steam under pressure, and the cholera patients, real or suspected, were isolated. It having been shown that it is practically impossible for a vessel to pass the Suez Canal in quarantine, without contact with the shores, it was resolved that no vessel should be allowed to pass into the Mediterranean unless it was free from infection or had been completely disinfected. Vessels from the Orient which have had no case of cholera since their departure will be allowed a perfectly free passage. Those which have had cases of cholera during the voyage, but none for seven days before arrival, will be allowed to pass the Canal in quarantine if they have a medical officer and a disinfecting stove on board. If not, they will be retained at the entrance of the Canal, where a sanitary station will be erected, and where the disinfection will take place. Infected vessels will be detained at the entrance, the patients will be disembarked and isolated, and the vessel will be disinfected. It is calculated that, out of 16,000 vessels that have passed through the Canal in five years, under the regulations now adopted twenty-eight would have had to undergo a delay of a few hours for disinfection, and two would have been detained for a few days.

MISCELLANEA.

A COMPANY is to be formed to provide the necessary means for carrying on the Engineering Exchange. The proposed capital is £10,000, in £10 shares, with £1 calls. The registered offices are at 33, Old Broad-street.

THE heavy gale which blew yesterday and last night has completed the wreck of the Inman steamer City of Chicago, on the rocks under the Old Head of Kinsale, on which she ran in a fog on Friday night, the 1st inst.

THE recent flood and fire which visited the oil regions, and caused such loss of life at Oil City and Titusville, caused heavy property losses, particularly among the refining industries; but, according to Stowell's "Petroleum Reporter," the whole damage is only estimated at £47,000 odd.

AT the Imperial Institute, turnstiles have been adapted to check the number of admissions to the Indian Art Section, and these, as well as the turnstiles employed at the Guildhall Art Loan collection, are the improved Norton pattern, designed and manufactured by Messrs. Le Grand and Sutcliff, of London.

AN American contemporary says:—The contract for the incandescent electric lighting at the World's Fair has been let to George Westinghouse, jun., on a bid of 399,000 dols., for 89,644 lamps. The alternating current will be used, and a bond of 1,000,000 dols. for the execution of the contract will be required.

AT the general monthly meeting of the Royal Institution of Great Britain on Monday, the special thanks of the members were returned for the following donations:—Professor Dewar—grant from the Royal Society—£300; Ludwig Mond, Esq., £120; Hugo Müller, Esq., £50; for carrying on investigations on liquid oxygen.

THE system of electrical signals, by which the results of the elections were nightly spelt out from the top of the tower of the National Liberal Club, is the invention of Mr. C. E. Kelway. The system of signalling was first shown at the Naval Exhibition, on the 24th October, 1891, and recently at the Crystal Palace Exhibition.

THE Emigrants' Information Office, 31, Broadway, Westminster, has just issued circulars and new annual editions of the penny and other hand books, with maps, showing the present prospects of emigration. Warnings against emigration to the northern provinces of Brazil are repeated, and there is little demand anywhere except for farm hands.

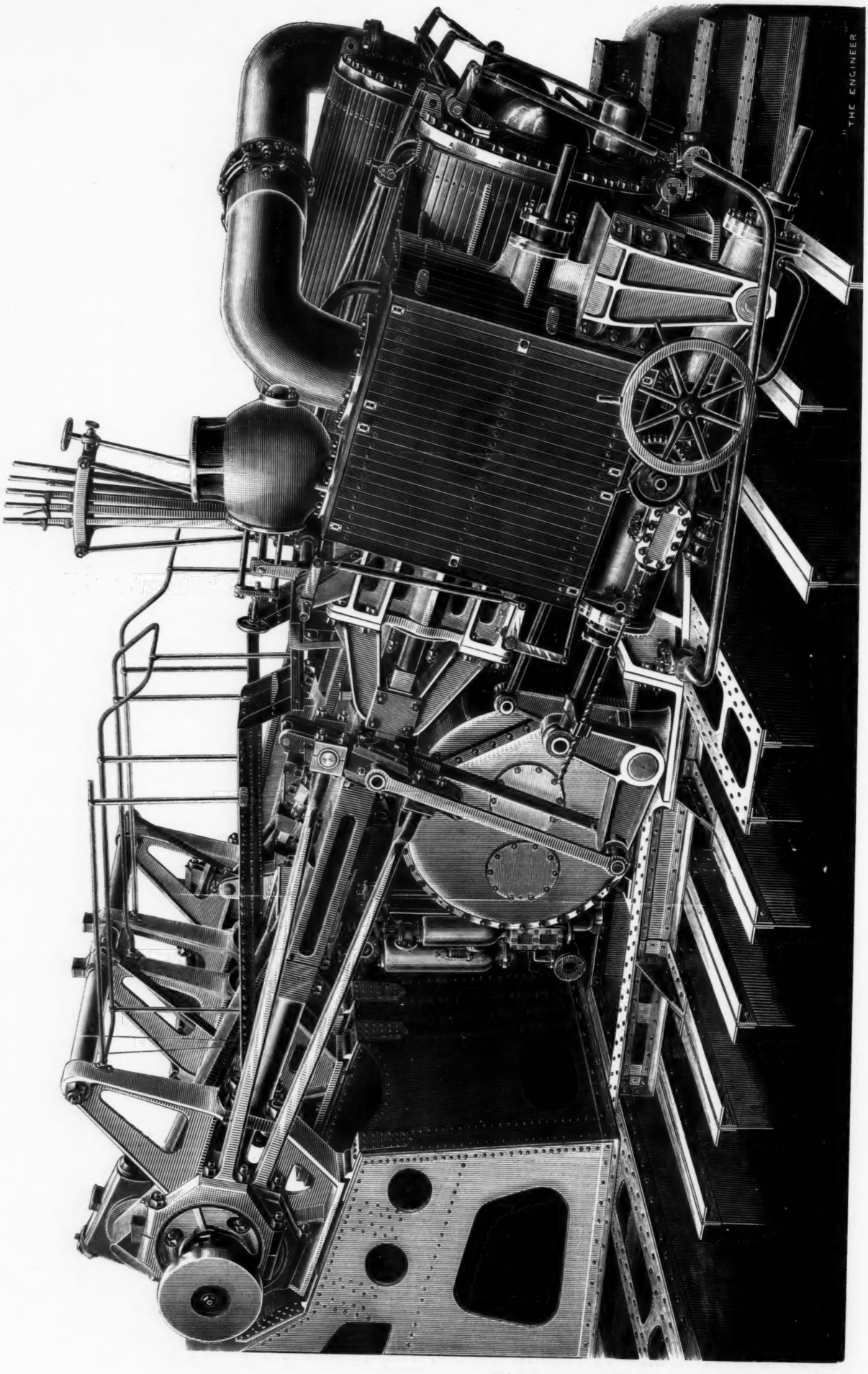
WE are informed that the Gas Committees of the Corporations of Burnley, Leigh, Bedford, and Gateshead have within a week placed orders with the New Conveyor Company for large installations of Little's patent steel wire rope conveyors and elevators, to convey the coal from the coal stores and feed it automatically into long ranges of retorts.

THE Rome correspondent of the *Times*, writing under date July 4th, says the inauguration of the new works for the lighting of Rome by electricity was celebrated to-day at Tivoli, in the presence of a large number of notabilities, including the Minister of Public Works. Tivoli is some twenty-five miles from Rome, and therefore special means had to be devised for conveying the electricity to the capital. The work was entrusted to an Anglo-Italian company, and by a most ingenious arrangement the waterfalls of Tivoli have been successfully utilised to produce the strong motive power necessary. The company is now capable of furnishing 600 arc lamps for public lighting, and 18,000 for private use. At nine o'clock this evening the Via Porta Pia was lighted with electricity from Tivoli.

WE have received particulars of a very large flour mill erected at Cardiff for Messrs. James Tucker, Limited, and capable of a product of about 50 sacks of finished flour per hour. The mill is divided into three parts, each complete in itself, and designed for a product of from fifteen to twenty sacks per hour. The whole of the machinery is designed on the roller mill system, with all the most recent developments in dressing machines, reels, centrifugals, dust collectors, and other apparatus now deemed necessary in the modern high-class flour mill; commencing with wheat cleaning, washing, stoning, and conditioning apparatus. The buildings are situated on the East Dock, Cardiff, and have over 300ft. of frontage. The engines have a total of 800-horse power, and with the whole of the rest of the machinery have been supplied by Messrs. Whitmore and Binyon, of Wickham Market. The buildings were designed by Mr. S. Rooney, the whole mill being planned by the firm already mentioned.

CONSIDERABLE progress has been made with the Blackpool south shore pier and pavilion. The method of pile sinking employed by Messrs. Butler and Co.—the contractors for the works—having quite fulfilled their expectations, and they feel confident of completing their share of the work by about the end of October this year. There will then remain to be erected the pavilion, band stand, shelter kiosks, and the entrance buildings. The designs for these have been prepared by Mr. Harker, A.R.I.B.A., architect, of Manchester; and it is expected that the contracts for the work will be let towards the end of this month. The pavilion will be in the Turkish style of architecture, and will have sitting accommodation for between 1700 and 1800 people. The construction is to be mainly of iron, the interior being finished in woodwork to correspond in style to the exterior. Shops are being provided around the pavilion outside, and we are informed that numerous applications have already been received by the directors for these premises. The entrance gates, offices and cloak-room buildings, will form a group harmonising in design with the pavilion, although more elaborate in detail, and will be a decided improvement to the south shore promenade.

AT the last meeting of the Canal Rates Inquiry Commission the case of the Grand Junction Canal was heard. Mr. Thomas, secretary of the canal company, said he thought it was reasonable that a short-distance charge of three miles for every boat should be made by the company. It was absolutely necessary to them that they should have power to charge a remunerative rate for this local traffic, which got the benefit of the whole of the expenditure of the undertaking. The toll charged on traffic which passed over the Slough Canal was a short-distance charge of four miles. On the Paddington arm of the canal they had spent a good deal of money lately. He denied that the result of their proposal would increase the rates—as against the Gas Light and Coke Company—by 7*8* per cent. The bulk of the traffic of the Gas Light and Coke Company came to about 2½d. a ton, and, assuming that the canal company charged the maximum three miles they were asking for, it would increase it to 4½d. Asked whether the canal company's purpose would be attained if, instead of having a mileage over traffic passing through a lock, they had a lockage, the witness said it would be fairer to treat it the other way, because the lockage charge was absorbed in the mileage when it passed over a greater distance than eight miles. No canal could be made to pay if it was to be charged upon mineral traffic; it was only the merchandise charge which enabled the canal companies to live at all. Mr. E. Clements, secretary to the Mansion-house Association, stated that the returns of traffic on the canal in 1888 showed the amount received in tolls to be equal to 11·55d. per ton, and an expenditure by the company for maintenance, &c., of works, equal to 6·44d. per ton, the difference representing the company's gross profits per ton. The proposals of the Mansion-house Association were for class A traffic for ten miles 4d., and for 20 miles 5d., or an average of 30d. per ton per mile. It was intimated at the close of the proceedings that the inquiry would not be resumed before the middle of October.



COMPOUND PADDLE ENGINES, S.S. KOH-I-NOOR

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, GOVAN, ENGINEERS

(For description see page 40)

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER

PARIS.—BOYVEAU and CHEVILLET, *Rue de la Banque.*
BERLIN.—ASHER and Co., *5, Unter den Linden.*
VIENNA.—GEROLD and Co., *Booksellers.*
LEIPSIC.—A. TWIETMEYER, *Bookseller.*
NEW YORK.—INTERNATIONAL NEWS COMPANY, *83 and 85, Duane-street.*

CONTENTS.

THE ENGINEER, July 8th, 1892. PAGE

ON THE CONSTRUCTION OF THE MODERN LOCOMOTIVE—THE FOUNDRY (Illustrated.) .. 25
STEEL CASTINGS FOR LOCOMOTIVE ENGINES .. 26
THE BRITISH NAVY UNDER THE PRESENT ADMINISTRATION .. 28
MANCHESTER SHIP CANAL .. 28
AMERICAN SOCIETY OF CIVIL ENGINEERS .. 29
THE MILLING EXHIBITION. (Illustrated.) .. 29
GARRING'S STEEL AND LEATHER LINK BELT. (Illustrated.) .. 30
THE RIVER THAMES STEAMER KOH-I-NOOR .. 31
ENGINES AT THE CRYSTAL PALACE. (Illustrated.) .. 32
MANCHESTER ASSOCIATION OF ENGINEERS .. 32
RAILWAY MATTERS .. 33
NOTES AND MEMORANDA .. 33
MISCELLANEA .. 33
COMPOUND PADDLE ENGINES, s.s. KOH-I-NOOR .. 34
LEADING ARTICLES — An Engineer's Ship of War — High-speed Locomotives .. 35
Agricultural Engineers and the Rating of Machinery—Carbonic Anhydride Refrigerators — The Five Days' Week — Working Expenses on Railways—Train Lighting—Locomotive Engines for New South Wales .. 36
LITERATURE .. 36
NAVY BOILERS. (Illustrated.) .. 37
CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892 .. 37
LETTERS TO THE EDITOR — Cyclone Wind Pressures — High-speed Locomotives .. 38
The Great Western Railway—Brake Horse-power—Hydraulic or Jet Propulsion—Proposed Varley Testimonial .. 39
THE PADDLE STEAMER KOH-I-NOOR. (Illustrated.) .. 40
THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS .. 40
NOTES FROM LANCASHIRE .. 40
NOTES FROM SHEFFIELD .. 41
NOTES FROM THE NORTH OF ENGLAND .. 41
NOTES FROM SCOTLAND .. 41
NOTES FROM WALES AND ADJOINING COUNTIES .. 42
NOTES FROM GERMANY .. 42
LAUNCHES AND TRIAL TRIPS .. 42
AMERICAN NOTES .. 43
NEW COMPANIES .. 43
THE PATENT JOURNAL .. 43
SELECTED AMERICAN PATENTS .. 44
PARAGRAPHS—Some Large Wire Ropes, 30—Anti fouling Paints in the Navy, 42—The Water Supply of Cromer, 42.

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J. T. G. (St. Mildred's-road).—*We do not think there is any demand for such an appliance. You might write to some of the architectural journals.*

PAPER EMBOSSING ROLLS.

(To the Editor of The Engineer.)

SIR,—I shall feel greatly obliged if any of your correspondents can give me the address of any makers of calender rolls or presses used for embossing paper, the paper being embossed in various fancy designs and silvered. The paper is embossed in sheets of about 28in. by 22in., and used for covering fancy boxes, &c.

July 4th. ENGINEER.

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THE ENGINEER.

JULY 8, 1892.

AN ENGINEER'S SHIP OF WAR.

MILES of letterpress have been printed and published and read and discussed concerning the construction and qualities of ships of war. We cannot call to mind that any of these disquisitions, or treatises, or papers, or books have emanated exclusively from the brains of engineers. Of course, without the aid of the engineer the modern warship could have no existence. But hitherto he has always taken a second place. He has been told to do this, that, and the other thing, and he has gone and done it; but little deference has been paid to any of his rare expressions of opinion. He has been told that naval matters are too hard for him, and that his true function consists in accomplishing the tasks set for him, and asking no questions. He is shown, for example, a very limited space on certain plans, and told to put engines and boilers into it which shall develope 10,000-horse power, or some other trifle of that nature; but he is not allowed to suggest that if he had a freer hand he could produce a better speed result, let us say, for less power. He is told that a gun is to be worked in a particular way, and that he must make the machinery for so working it; but he is not permitted to point out that the thing admits of being done better in another way. He is not snubbed exactly, but he has been taught to keep his own place, and stand hat in hand when the naval architect, the artillerist, and the sailor pass by. Considering how very important is the part played in a compulsorily disjointed fashion by the engineer, we venture to think that he has not been treated quite in the way that he deserves, and we go so far as to ask, Is it not about time that the engineer took the initiative, and reversing the normal practice, employed the naval architect and the artillerist to carry out *his* designs? We hold that there can be but one sound answer to this question, and it may not be unprofitable to consider in what way the engineer would probably go to work.

It goes without saying that he would come to the task of designing a fighting ship with a very fair knowledge of what has already been done, and with a mind quite free from prejudice. His first endeavour would be to produce an honest ship, a vessel quite free from shams of all kinds. What we mean by this will become clear as we proceed. It is of paramount importance that whether a ship of war can do much or little, she must be able to do that much or little as well as it can be done. For example, she may be able to steam at twelve knots an hour, or at eighteen knots, or any intermediate speed. But whatever her stated pace, she must be able to keep it up for any number of hours without fear of a breakdown, and without exhausting her crew. In the same way she may carry a gun or guns of any given size, but they must be honest weapons, which may be trusted to fire away all the ammunition she can carry without bursting, or dropping at the muzzle, or playing any other prank. In the same way rapidity of firing must be regarded as quite subordinate to the certainty of being able to fire. Thus, for example, if there are two methods of working a given gun, and one means ten rounds in ten minutes, and the other means five rounds in ten minutes, the engineer will adopt the latter provided the mechanism is simple, and sure to be worked with success in the heat and confusion and turmoil of action, when men's hearts beat fast, and their breathing is quick, and their hands shake, while the rapid fire can only be got by the aid of delicate appurtenances, requiring coolness and steadiness to work them without a breakdown. Want of space prevents us, of course, from doing more than hinting at the way in which an engineer would deal with the problem, but our engineer readers will be able to amplify for themselves as they go on.

A very early step in the process of solving the problem consists in settling how big or how small things are to be. We fancy that a ship with a displacement of about 5000 tons will satisfy all the requirements of an engineer. He will be moderate in his promises, but then they will certainly be kept. As to the shape of the hull and her lines, these must be settled by the naval architect, acting under the general instructions of the engineer. The latter will be very careful not to try for too high a speed. About 16 knots will be the maximum aimed at, to be had with a forced-draught pressure of certainly not more than 1in. If the ship has good lines this speed ought to be easily got with about 6000 indicated horse-power; probably less would suffice. It must be very clearly understood that this 16 knots is the true sea speed of the ship, and not a fancy result got on a four hours' run, with picked coal and selected stokers. This is essential, because of the way in which the ships would be worked. There would always be three precisely similar vessels cruising in company. They would be as much alike as three Martini-Henry rifles. Every part of each would be interchangeable with any other of the three, and as the sea speeds of all would be the same, there would be no waiting for the slowest, and they could always keep in company save in the wildest weather. Three such ships ought to be able to give very great trouble to any one warship of, say, 14,000 tons, although one alone would have to take to her heels. Once more the limits of space prevent us from enlarging on the merits of this multiple unit system of action, a system which can only be carried out when the vessels composing each unit are really identical.

The engineer would not leave his craft absolutely without armour. We have been told by more than one gallant admiral—somewhat late in the day it is true—that it is quite impossible to hit a vessel with rifled shot anywhere near the water-line; and, taking them at their word, the engineer would leave his ship without any belt; but, on the other hand, he would provide really adequate defences for the numerous quick-fire light guns which she would carry on the broadside; and these defences could be so contrived that the guns might be fought although the upper works of the ship were involved in one general ruin. In like manner the engines would be protected. The engineer would make the machinery of the ship his first consideration, and he would not stint the engines in height. An armour deck to keep out shells, supplemented by coals, and an armour trunk round what we may term the engine hatch, would make things reasonably secure. Too much could not be attempted. We come now to perhaps the most important feature in the whole vessel, namely, her armament. The engineer has learned by this time that two conditions appear to be essential. The first is that the gun must be thoroughly trustworthy; the second, that it must be high out of the water. Now the way in which a ship of the kind we are sketching would be fought closely resembles the system adopted in old times by the smaller craft. They carried carronades on the broadside, perhaps five on each side, and forward a long brass 32-pounder. This weapon had considerable range, and was really the most powerful gun in the ship. We have only to read naval history to learn how such guns were used. The engineer would reproduce this system on a greatly enlarged scale. While 4in. would be about the size of the largest broadside gun, he would mount forward an 8in. quick-fire gun, weighing 14 tons, and competent to penetrate 16in. of armour at 1000 yards, and he would not hesitate to put an extra ton of steel into it to get strength. To mount this gun in a turret would never do. The engineer, as we have said, will have no shams on board his ship, and a turret that would really protect the gun would be much too heavy, and the gun would be kept too near the water. On the other hand, a barbette, while very heavy, would scarcely supply adequate protection, and, as in the case of the turret, it would leave the gun too near the water. The way out of the difficulty lies in adopting a modified form of the disappearing carriage. The gun could then be fired from an abnormal height above the sea, and then returned to a place of comparative safety within a species of armoured redoubt forward. All the arrangements would be suitable to the rough-and-ready handling which the weapon would undergo in an engagement; ample provision would be made for torpedoes.

It may be said that a 5000-ton ship could easily carry two such guns instead of one. Indeed, we are quite certain that the artillerist would put a much heavier armament into her than that suggested, while the naval architect would put on more armour, and the sailor would put on more speed. But the engineer, wiser in his generation, knows that the great defect of all warships lies in the attempt to do too much. They are like the "General Genius," who professes to carry away all the world's prizes, and ends in winning none of them. The engineer knows that in the long run, if there is fighting, a ship which can keep on shooting for an hour at the rate of a round every two minutes, will stand a far better chance of victory than a ship which can fire a round a minute for three minutes only. But the engineer's ship would possess an enormous advantage, in that she could always be trusted to steam for long periods at a high, though not the highest velocity. There are in modern men-of-war a thousand-and-one details that they would be better without. For example, what is the use of an elaborate series of speaking tubes from the forward conning tower to the engine-room, down which no intelligible message can be transmitted, even under ordinary conditions when the engines are running, and which would be utterly useless in the noise of an action? What can be said in favour of electrical signalling arrangements which cannot be trusted even on a peaceful cruise? The engineer would take very good care to provide signalling arrangements which, if they did not permit the captain and the chief engineer to consult with each other, would not fail to tell the latter what the former wanted the engines to do. In one word, the engineer's warship would be less of a scientific museum and more of a floating gun-carriage. Her claims would be modest, but what she promised to do she could do. The story told by past naval manœuvres goes to show that the promises of the modern warship are seldom kept; and this simply because more is attempted than the wit of man can carry out.

HIGH-SPEED LOCOMOTIVES.

MR. ROUS-MARTEN'S letter, which will be found in another page, will no doubt be read with the attention which it deserves. What Mr. Rous-Marten has to say about locomotives is always worth reading, because he has had excellent and unusual opportunities of acquiring information and understands the art of utilising his knowledge. It does not follow, however, that his utterances must be accepted without question, and there is a good deal in his present letter to which exception may, we think, be legitimately taken. In brief, his contention is that the velocity which a locomotive can attain is purely a question of the power which it can develope, and that the internal resistance of the machine may be reduced by shortening the stroke of the piston, and augmenting the initial pressure. The first statement is true, only with limitations on which our correspondent does not sufficiently insist. Given, he says, a train of a certain weight, then the speed at which it can be hauled depends on the power of the engine. By power he clearly means horse-power. To put things in another way, he contends that only a big engine can haul a train of reasonable dimensions at a high speed. Now all this is true in a sense, but it is not the whole truth, and it misses the real *crux*, which is, that no matter how big the engine may be, although it is hauling no train, it seems to be proved that a speed much over eighty miles an hour is impossible of attainment. We say "seems," because the very few cases in which higher velocities have been attained are so strictly exceptional that they lead us to suppose that some altogether exceptional influences are at work to help the engine. We may proceed to consider his propositions from more than one point of view; and in the first place inquire how far it is true that a very large engine is needed, under all circumstances, to obtain a high velocity.

We may take 80 tons as a reasonably heavy train. That was about the weight, for example, of the West-coast "flyer," run during the race to the North. This train was hauled all the way to Crewe, a distance of 158 miles, by the Waverley, an engine built in 1863, with outside cylinders 17in. diameter and 24in. stroke, and single driving-wheels 7ft. 7in. in diameter. The total weight of this little engine is but 27 tons; that of the tender is 17·5 tons, or together 44·5 tons. Taking the tender as part of the train, and allowing for passengers and their luggage, we have a gross weight of 97 tons hauled by an engine weighing 27 tons, or $\frac{1}{3{\cdot}6}$ of the train nearly. The run was made to Crewe

at an average speed of 57·1 miles per hour. We may compare this performance with that of Mr. Buchanan's enormous engines illustrated in our impression for June 17th. We shall credit the engine with the heaviest train it has hauled, and add the tender; we have then a gross load of about 190 tons. The engine weighed 52 tons, or about $\frac{1}{3{\cdot}6}$ of the train. The proportion is therefore almost precisely the same in both cases. But the average velocity of the Empire State express is several miles an hour behind that of the Waverley. So far then as actual practice is concerned, it does not appear that we have any grounds for assuming that higher speed can only be got with a big engine. On the contrary, there is every reason to believe that a very high velocity can be attained on a level track with a light engine hauling a light train just as easily, if not with more ease, as by a heavy engine pulling a proportionately heavy train; and further, there is no reason to doubt that if the Waverley were placed on one line of rails and Mr. Buchanan's engine on another, and they were started fair, for say Crewe, without any trains, the little engine would run as fast and get to its destination as soon as the big one. From all which we deduce the conclusion that it is quite unnecessary to build larger engines than we are now using in case it should be deemed desirable to establish a very fast train service. It is to the carriage builder rather than to the locomotive superintendent that we must look for progress in this direction. It may be laid down, let us say, that the weight of the limited express shall not exceed 100 tons. It will then devolve on him to produce coaches with the maximum accommodation for this weight; and we have no doubt but that a great deal could be accomplished in this way by the use of hollow steel structures and special woods. We do not suppose that Mr. Rous-Marten will traverse our statements so far. Indeed, we do not think he means his readers to believe that high speeds can only be attained by very large engines, although that construction may be put on his words.

Mr. Rous-Marten's utterances concerning piston-stroke open up a most important question. It is one thing to get indicated power in plenty, it is another thing to utilise it in hauling a train, and we may say here that we have no doubt whatever that a light engine spends more of its power on the draw-bar than does a heavy engine, principally because the road resistance to the latter will be greater. Experiments with dynamometer cars have shown that of the whole indicated power exerted by the engine, in certain cases not more than 40 per cent. reached the train, and we shall probably be within the mark if we say that for 100 horse-power indicated under favourable circumstances with fast trains, not more than 60-horse power reaches the train. We have already very fully discussed the whole question of train resistances, and we need not go over the ground again. The view we have taken has never been controverted, and has indeed been very freely accepted; it is, that the maximum train resistance is due to the fact that the leading end of the engine is to all intents and purposes running up hill, owing to the yielding of the rails under its tread; and that a very inadequate return is made by the continual running down hill of the last pair of wheels in the train, as the road resumes its level. The compensation would only be complete if the road were perfectly elastic, which it is not nearly. The resistance on which Mr. Rous-Marten insists is not, however, one which affects the use made of the indicated power. Back-pressure reduces the indicated power of the engine, and it is with it that Mr. Marten proposes to deal. It must not be forgotten that the whole work done by the engine includes that expended in overcoming back-pressure, although it is not credited on the diagram; and we have no doubt that it is the difficulty of getting the steam fast enough out of the cylinder that prevents very high speeds from being attained. Mr. Rous-Marten's theory that high-pressure steam, with an early cut-off, would cause less resistance than lower pressure steam with a later cut-off, will not, we think, hold water in practice. The greater the expansion the wetter is the steam likely to be at the end of the stroke, and Mr. D. K. Clark's experiments prove conclusively that wet steam and a high back pressure always go together. Mr. Rous-Marten holds that there is also a loss incurred by the influence of inertia on the reciprocating masses, and he would diminish this by shortening the stroke. On this point, however, he is either mistaken, or at least exaggerates the possible advantage to be secured. It is not so much the reciprocation as the number of reciprocations per mile, or per minute, that has to be considered, and it is not to be forgotten that an addition to the diameter of a locomotive engine cylinder adds far more to the weight than does an addition to its length. We can have either a long stroke or an addition to the piston area, and on the whole we believe that for high speeds nothing worth mentioning is to be gained in the way that Mr. Rous-Marten proposes. Attempts should be made to get the steam out of the cylinder with more freedom than is possible under existing arrangements.

Mr. Rous-Marten directs attention incidentally to a very curious point, namely, the small influence which heating surface seems to have on the power of a locomotive. At first sight it appears incomprehensible that 1200 square feet of surface should do just as well as 1500, or even more, but the statement ceases to be puzzling when we consider how and where the additional surface is supplied. The diameter of the locomotive boiler is pretty rigidly limited to, say, 4ft. 3in., therefore the number of tubes that can be got is limited, and thus we find that engines with large heating surface have very long tubes. No doubt such tubes are more economical than those which are shorter; but the extra couple of feet does not add much to the steam-making powers of the boiler. It is not, we think, too much to say that nine-tenths of all the steam made are produced by the fire-box and the first 3ft. in length of the tubes; consequently so long as the grate is large and the fire-box of commensurate dimensions, the boiler will make plenty of steam, whether the tube surface is large or not. We could cite cases in which engines which were otherwise powerful enough did not steam well. They had the original fire-boxes replaced with others about one foot longer. The grate area was augmented by about 3 square feet, and the fire-box surface by about 14 square feet. To say on paper that one engine has 1200 square feet of heating surface, and the other 1214 square feet, does not seem to involve much. As a matter of fact, however, it has probably augmented the power of these engines by quite 25 per cent.

TRAIN LIGHTING.

A very great development in the lighting of railway carriages seems to have set in, in England, in India, in the United States, and in Australia. It has taken a great many years to accustom our railway directors to the fact that railway carriages can be lighted very much more perfectly by means of oil-gas than with oil, at a very much lower cost, with very much lower maintenance charges, and with absolute freedom from the damage which frequently occurs as the result of the use of leaky oil lamps, and of broken lamp globes. For some years the best lighted railway carriages were to be found on the German lines, but the system there adopted is now, with some improvements, rapidly extending in use all over the world. We learn, and those that travel on the Midland Railway will be glad to know it, that that enterprising company has just determined to have nearly 900 more of its carriages fitted with gas-lighting apparatus, and that for this purpose three more oil-gas works are about to be constructed at Birmingham, Leeds, and elsewhere. The Great Indian Peninsula Railway has recently completed oil-gas works, and gas-lighted trains are running on the Bombay and Poonah line. Oil-gas works have been completed on the Bombay, Baroda, and Central Indian Railway, and the first trains are running on that line. The East Indian Railway Company has ordered the construction of several oil-gas works for Howrah, Allahabad, and elsewhere, and trains are to be provided with gas fittings on this line, on the Madras Railway, and on the Southern Mahratta Railway. It will now be possible to run trains provided with gaslight for three nights' consumption, or for the whole journey from Bombay to Calcutta. This great extension of the gas-lighting of trains, all of which is on the Pintsch compressed oil-gas system, would appear to show that experience with electric lighting for this purpose is not in its favour.

THE RATING OF MACHINERY.

It is to be hoped that one of the subjects which will occupy the early attention of the new Parliament will be the exemption of machinery from rating. A Bill of some sort or another upon this subject has been before Parliament almost every year since the deliberations of the Select Committee which sat from March to July in 1887; yet the subject remains full of inconsistencies, and a clear definition of the law is urgently needed. It is to be hoped that the recent second reading of Mr. Gerald Balfour's Bill will be speedily followed by legislation of a more complete nature. An instance of the heavy manner in which the present state of the law presses upon agricultural engineering is afforded by the experience of Messrs. Marshall, Sons, and Co., of Gainsborough. That firm are resisting the proposals of the Assessment Committee of the Gainsborough Board of Guardians who suggest such an alteration as will increase the rates of the firm by over £1000 a year, and it is stated that the matter is likely soon to come before the law courts as a test case. In 1884 the works of this well-known Gainsborough firm, as well as those of the large agricultural engineering firms in Lincoln and Grantham, were all re-valued. It would hardly seem as though the same principle underlaid the valuation in all these cases, seeing that Marshall, Sons, and Co.'s gross assessment came out at a much higher figure than those of Clayton and Shuttleworth, £5460; Ruston, Proctor and Co., £3450; Robey and Co., £2310; and Richard Hornsby and Son, £3000. It is probable that Marshall, Sons, and Co.'s heavy machinery was included, whilst the other firms escaped that impost; for the gross assessment of the last-named firm is now £10,000, and the net assessment £6666. Other cases could be cited in which engineers, both agricultural and general, are seriously affected by the uncertainty which prevails in rating practice, and members of these industries trust that the efforts of the National Society for the Exemption of Machinery from Rating, and of all whose views tend in a similar direction, may before long result in the passing of a more satisfactory legislation.

CARBONIC ANHYDRIDE REFRIGERATORS.

On Tuesday Messrs. J. and E. Hall invited a number of those interested in the construction and working of refrigerating machinery, as used in cold storage establishments and on board ship, to witness the operation in their works at Dartford of a large carbonic acid refrigerator, made for Messrs. Nelson Brothers for one of their large sheep-freezing establishments in New Zealand, where over 2000 sheep are frozen per day. The principle upon which the machine works is the compression at a pressure of about 700 lb. to the square inch, of carbonic anhydride; its liquefaction in a condenser consisting of coils of tubes kept cool by circulating water, and the subsequent evaporation of the liquid carbonic acid in coils surrounded by a brine mixture. The pressure is relieved in these tubes and falls to about 300 lb., re-evaporation of the carbonic acid taking place, accompanied by the absorption of heat from the brine in the brine tank, and the consequent lowering to a temperature of, say, 20 deg. of the brine. The latter being thus reduced to any desirable low temperature, may be circulated through pipes in cold storage warehouses, ice-making tanks, or used for any other refrigerating purpose. After evaporation and fall to a pressure of 300 lb. on the square inch, the carbonic acid is sent back to the compression pumps, and again compressed to about 700 lb. on the square inch to repeat the process. Liquid carbonic acid is now obtainable at so very low a price that it commends itself for this purpose, and the refrigeration effected by its use costs for fuel only about one-fifth the cost of fuel for refrigerating by compressed air. A very large number of these machines has now been made, and of these we shall give some further particulars.

THE FIVE DAYS' WEEK.

Too little attention has been given to the quiet way in which something like an industrial revolution has been wrought in the coalfields of the kingdom. When the miners' leaders first suggested one stop-day a week the public were alarmed, and pit proprietors anticipated gravely prejudicial results. A few cool heads surveyed the situation. They made no speeches at public meetings or organised opposition amongst their order. Wiser counsels prevailed. They had noted how quickly any proposal prospered amongst the miners once the mineowners went against it. They therefore ignored the principle of restriction, and considered how best to meet the evil with the least amount of mischief. They suggested that the stop-day should be Saturday. The miners' leaders favoured Monday. Eventually Saturday was agreed upon. What has been the result? The men have practically worked as much in the five days as they used to do in the six. For some time there has not been more than four days' work for the colliers, owing to the depressed state of trade; but in the localities where the full five days have been worked there has been more real labour crowded into the diminished week. We hear no complaints now of men idling their time, and quite as much coal is being brought to bank as the country requires. At the same time prices are weakening, and although all is quiet in the labour market at present, it will be impossible in the face of a falling market to keep up wages at the full 40 per cent. advance secured during the last three years. Still there is no sign of any movement amongst the masters to disturb the situation, and it is extremely unlikely that the men will seek to alter what suits them literally down to the ground, and under it.

WORKING EXPENSES ON RAILWAYS.

It can scarcely be said that the half year that will soon be reported on has been, on the whole, a good one for the chief railways of the United Kingdom. In some instances there are increases in the traffic—as, for instance, in the case of the Manchester, Sheffield, and Lincolnshire, which records a comparatively large increase. In others, such as the Midland, the revenue is practically stationary; whilst the North-Eastern feels the effect of the strike that for three months affected its Durham traffic, so that the result is scarcely one that is satisfactory in the aggregate. It is quite possible that there will be some savings in the working expenses of many of the chief lines. On the North-Eastern, scores of passenger trains were discontinued during the strike, as well as mineral trains, so that there must be in that way, and in the short time that was worked during the strike in the engineering and carriage building shops, a very great saving to set against the vaster loss of revenue. Then there are some features of economy that must be common to most of the railways, for coal, iron, steel, and other metals have been cheaper than they were, though against such economies must be put some possible increases in wages when contrasted with those of a year ago. The chief Scottish railways will contrast their half-year with that in which the strike affected them, and they have fuller traffic and proportionately lower expenses. The Irish railways do not compare so well, but they will have, in one or two cases, very great savings in the item of compensation. But the generel result of the working must be, when increased capital charges are remembered, a tendency towards a reduction of the dividends in most instances, though in some they will probably be maintained.

LOCOMOTIVE ENGINES FOR NEW SOUTH WALES.

We concluded an article containing a condensed report of Mr. Eddy's statement, in our last impression, with the words, "The decision of the Commissioners on these points will be awaited with interest on both sides of the Atlantic." We have just received a telegraphic dispatch from Sydney which states that the Royal Commission reports that the Baldwin engines are not unsuitable to the colonial permanent way. The design of them is not defective, and when the objectionable tires and axles have been removed and replaced by others of approved quality, the engines will render the service expected. The Commissioners recommend the strengthening of the old iron and the renewal of the old timber bridges on the lines, and the relaying of rails and reballasting of track be proceeded with. The passenger engines must have new axles and tires before they are to be permitted to take passenger trains. It will be seen this report virtually exonerates Mr. Eddy, Mr. Neale and others implicated in the charges which the Commissioners were appointed to investigate. It can scarcely be said, however, that the Baldwin works come out satisfactorily, and it is greatly, we think, to be regretted that circumstances forced Mr. Eddy to go to America for what he would have got much better in this country.

LITERATURE.

Travels amongst the Great Andes of the Equator. By Edward Whymper. Second edition. London: John Murray. 1892.

As our readers are already aware, it has long been a matter of discussion as to whether human life can be sustained at any great elevation above the level of the sea, and the conclusions arrived at by different authorities on the subject have been as conflicting as the evidence on which they are based. With a view to ascertaining the truth on this much-debated point, it occurred to Mr. Whymper to plan and undertake the journey to Ecuador, of which the volume before us is the record—a record, be it said, of patient toil, involving dangers and deprivations such as the pursuit of a long-cherished end could alone have rendered tolerable. To say that Mr. Whymper endured, in the course of his six months' travels amongst the Andes of the Equator, every conceivable hardship and discomfort—from snow blindness to semi-starvation—would be to state the case very mildly; but in the true scientific spirit, he touches very lightly on these drawbacks, deploring them chiefly as hindrances to the work he had set before himself—which was, in fact, a no lesser task than the ascent of some of the higher peaks—notably Chimborazo, "the grandest mountain in the world," as Humboldt called it. The Herculean labour of ascending it was unsuccessfully attempted by that distinguished naturalist in 1802, who reached—as he believed—a height of 19,286ft., though Mr. Whymper's own observations led him to doubt whether Humboldt could ever have got higher than 18,400ft. How this error in Humboldt's calculations arose it is difficult to explain, as he not only possessed the mercurial barometer, but knew well how to use it. A second attempt to ascend the mountain was made in 1831 by Boussingault; but to Mr. Whymper remained the triumph of first setting foot on the summit, after encountering and overcoming difficulties which might well have been considered insuperable. None but an experienced mountaineer could have ventured to

make the attempt; and if Mr. Whymper had not added considerable forethought and knowledge of his subject to his love of adventure and powers of endurance, the present volume, while it might have been almost as attractive to the general reader as an unusually good book of travel, would not have been the valuable addition to science which it actually presents. Some idea of the difficulties with which Mr. Whymper had to contend may be formed, when it is said that the laborious preparations for the ascent had to be carried on in a sparsely populated, half-civilised country, scarcely emerged from mediæval barbarism, whose inhabitants—chiefly descendants of the early Spanish settlers and aboriginal Indians—could neither understand the objects, nor effectually second the efforts of the traveller and his two assistants; but for whose able services, indeed, the remarkable results recorded could scarcely have been achieved. Great indeed was the incredulity which prevailed in Guaranda when the news spread that the author and his two companions intended to ascend Chimborazo, with the object of making scientific investigations. At length the principal official addressed Mr. Whymper thus:—

"Senor, we understand perfectly that in an affair like yours it is *necessary* to dissemble a little, and you doubtless do quite right to say that you intend to ascend Chimborazo, a thing that everybody knows is impossible. *We* know very well what is your object! You wish to discover the *treasures* which are buried in Chimborazo, and no doubt there is *much* treasure buried there, and we hope you will discover it, but we hope when you have discovered it you will not forget *us*."

Mr. Whymper's plan of action was to place camps at intervals from Guaranda, the base of operations, at successively greater elevations on the slopes of Chimborazo, thus forming a complete line of communication in case of need. It was at the second camp, an altitude of 16,000ft., that symptoms of mountain sickness first attacked the party.

"When the others arrived at the second camp we ourselves were in good condition—which was to be expected, as we had ridden most of the way; but in about an hour I found myself lying on my back with both the Carrels placed *hors de combat*, and incapable of making the least exertion. We knew that the enemy was upon us, and that we were experiencing our first attack of mountain sickness. We were feverish, had intense headaches, and were unable to satisfy our desire for air, except by breathing with open mouths. This naturally parched the throat and produced a craving for drink which we were unable to satisfy—partly from the difficulty in obtaining it, and partly from the trouble in swallowing it . . . . Before a mouthful was down, we were obliged to breathe and gasp again, until our throats were as dry as ever. Besides having our normal rate of breathing largely accelerated, we found it impossible to sustain life, without every now and then giving spasmodic gulps, just like fishes when taken out of water. Of course there was no inclination to eat; but we wished to smoke, and found that our pipes almost refused to burn, for they, like ourselves wanted more oxygen."

The sufferers derived some relief from sucking chlorate of potash which had been brought by the advice of Doctor Marcet. It has been suggested that the large proportion of oxygen contained in the salt, supplies to the blood what, in these regions, it fails to derive from the air; but whether this be so or not, it is certain that in the course of twenty-four hours the travellers were slowly recovering from the more distressing symptoms, and able to continue the ascent. Curiously enough, this was their first and last serious attack of mountain sickness, although a whole night was spent by the party close to the crater of Cotopaxi; an elevation of 19,500ft., as compared with 16,664ft., and with the barometer at 14·748in., as compared with 16·500in. on Chimborazo. From this, and subsequent experience, Mr. Whymper answers the question he set out to determine, in the following manner:

"The various affections which have been classed together, confounded and confused, under the single term Mountain-sickness are fundamentally caused, as I see the matter, by diminution in atmospheric pressure, which operates in at least two ways, namely, (*a*) by lessening the value of the air that can be inspired in any given time, and (*b*) by causing the gas or air within the body to expand, and to press upon the internal organs. The results which ensue from *a* are permanent—*i.e.*, so long as the cause exists—and are aggravated the more pressure is reduced. The effects produced by *b* may be temporary and pass away when equilibrium has been restored between the internal and external pressures; or they may be fatal under very large and rapid reduction in pressure. It follows . . . that the evils coming under *b* will be minimised by gradual ascent, and may even be entirely avoided by keeping a constant watch over the rate of the pulse and the temperature of the body. But from the effects on respiration none can escape. In every country and at all times they will impose limitations upon the range of man; and those persons in the future who, either in pursuit of knowledge or in quest of fame, may strive to reach the loftiest summits on the earth, will find themselves confronted with augmenting difficulties which they will have to meet with constantly diminishing powers."

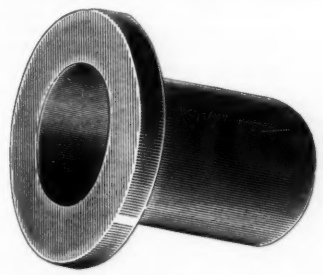
After some months spent in investigating the heights and characteristic features of some other notable peaks of the Equatorial Andes, comprising Cayambe, Antisana, Altar, Illiniza, &c., many of which are higher than Mont Blanc, Mr. Whymper made the ascent of Chimborazo a second time from the north-north-west, and his observations on that remarkable mountain, hitherto practically unexplored by man, may be summed up as follows:—In the first place, Chimborazo is not 21,440ft., as our atlas tells us, but 20,498ft., if we may trust the readings of the two mercurial barometers carried with such constant care by Jean-Antoine Carrel as to be nicknamed "the babies." The summit is crowned with two peaks, one of which is slightly higher than the other. It is in all probability an extinct volcano, and possesses at the present time numerous glaciers. Mr. Whymper counted and named no fewer than eleven, which makes Humboldt's statement that he saw nothing in the tropics resembling the glaciers of Switzerland hard to understand. That they are not less dangerous to mountaineers than those of the Alps Mr. Whymper proved in an unpleasantly practical manner, as he narrowly escaped losing his life by falling down a crevasse when crossing a glacier on the slopes of Antisana. Fortunately he was roped to his two companions, but for which happy precaution the accident would almost certainly have proved fatal. As it was, "with slow and anxious pulls they hauled away, fearing that the rope would be severed by the glassy edges; but before my head touched the bridge more of the brittle structure yielded, and I went down again." Fortunately their efforts were successful, and Mr. Whymper was at last safely drawn to the surface, not much the worse for his unpleasant adventure.

And here we must take leave, with regret, of a book which ought to prove useful and interesting from many points of view, for besides the main object of his journey, Mr. Whymper devoted much attention to the study of the antiquities of the country, to the formation of botanical and zoological collections at great heights—in a land which offers a grand field for an enterprising naturalist, and last, though not least, to the comparison of boiling-point observations and aneroids against the mercurial barometer, the results of which he has epitomised in some very concise tables, to which we must refer our readers for more detailed information.

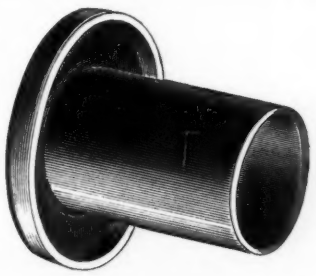
NAVY BOILERS.

A MOST important and noteworthy success was achieved on Saturday week with the boilers of H.M.S. Thunderer on a forced draught trial in the Solent, the boiler tubes having been recently fitted at the combustion chamber ends with ferrules specially designed by the Admiralty engineers, an illustration of which appears herewith.

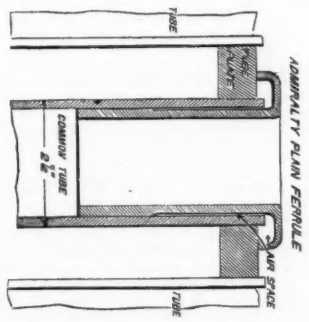
It is a notorious fact that this important battleship has been lying for months at Gibraltar, practically useless, on account of persistent leakage of the tube ends



whenever an attempt was made to steam for any length of time at even moderate speeds. She was commissioned in March, 1891, for service on the Mediterranean station, after having been put through the usual service trials of the new machinery and boilers supplied by Messrs. Maudslay, Sons, and Field in accordance with Admiralty requirements. The boilers, of which there are four, are cylindrical, double-ended, with single combustion chambers and six furnaces in each, a type which it is well known has given



endless trouble when forced much beyond their ordinary natural-draught power, owing to leaky tubes. They were intended to supply steam to twin-screw engines capable of developing 7000-horse power, with a plenum equal to 2in. of water in the boiler-rooms; but on account of difficulties with other boilers of a similar type, it was decided to accept the machinery on a natural-draught trial—equal to ½in. of water—if the specified power of about 6000 horses was successfully maintained for eight hours. This



condition was easily satisfied, and though there were some indications of future trouble when the ship was put through her six hours' commissioning trial at natural draught, owing to some slight leakage of the tubes afterwards, it was thought to be unimportant, especially as the defects were made good by the ship's staff, and she was allowed to proceed to her station. She had scarcely arrived at her destination, however, when her troubles began. One day, when steaming in company with the fleet, it became necessary to increase the speed of the fleet to ten knots to reach harbour before dark, and in attempting this feat the Thunderer broke down so badly that she had to drop out of line and take her own time to get into harbour. The then Commander-in-Chief, Sir Anthony Hoskins, now First Sea Lord of the Admiralty, naturally incensed at this behaviour of what was considered to be practically a new battleship, ordered a court of inquiry, the result of which was that the ship has never taken her place in the line of battleships in the station, but remained at Gibraltar until a few weeks since, pending the results of some experiments which were being conducted by the engineer authorities of the Admiralty, to attempt a solution of the difficulty.

Many ingenious devices have been tried, among others a patent screwed ferrule of Messrs. Humphry's design. Tubes with thickened ends, tubes with copper ends, thinner tube plates, and a plain ferrule with a mushroom top protecting the tube end and the plate in the immediate vicinity, of Admiralty design, the chief point of which is that there is no contact of the ferrule with the tube until it is well inside, where the heat can rapidly be conveyed away by the surrounding water, thus preventing overheating at the point where the tube passes through the plate. The screwed ferrule of Messrs. Humphry's is understood to have succeeded admirably in obviating the leakage of the tube ends even at extreme forced draught, but obviously the work of screwing ferrules into the tube ends is such a slow and costly process, and moreover a process that cannot be repeated on the same tube, that if a plain ferrule could be made to succeed, the Admiralty pattern one would be the choice of most seagoing engineers.

This plain ferrule has been subjected to the most severe trials possible on board H.M.S. Barracouta, and has proved efficacious beyond expectation in preventing leakage of the tubes. The success was so marked that it was determined to fit them to the boilers of the Thunderer for further test, with the result that on Saturday week the ship was put through a four hours' forced draught trial with the greatest *éclat* and success, 7000-horse power—or about 16-horse power per square foot of grate—having been easily obtained with entire immunity from leakage, only about two tons of fresh water having been required to make up for the losses of the day, which is evidently a very small amount when it is considered that the safety valves are continually lifting when the boilers are being pressed to their utmost power. This may be reckoned as one of the greatest successes which has been attained in recent years in overcoming engineering difficulties. The attempt to attain high powers with light machinery, laudable and necessary as it may be, has set a great many problems for engineers to solve, both with machinery and boilers, but the most difficult problem of all has been to obtain trustworthy marine boilers capable of giving 20-horse power per square foot of grate working under the ordinary conditions of service afloat. These results have often been and are being attained or even exceeded by small locomotive boilers on shore and in some torpedo boats, but the conditions are so different that comparison is impossible.

It is impossible to overrate the importance of this success, for important ships like the Blenheim, Blake, Vulcan, and Devastation may now be brought up to the power and speed for which they were originally designed, without incurring the expense of new boilers, which, at one time, it was thought would be necessary. In fact, it may be said that nearly £100,000 sterling will be saved to the country in this year alone by this ingenious device; but money value, large as it is, sinks into insignificance beside the ever-important consideration of the additional speed to be obtained by means of this extra power provided by boilers whose tube-plates are protected by the Admiralty ferrule.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

THE following are the awards made by the jurors:—

Diploma of Honour.—H.M. Post-office, L.B. and S.C. Railway Co., L.C. and D. Railway Co., L. and N.W. Railway Co., National Telephone Co., Exchange Telegraph Co., Crosaley Brothers, J. Swinburne and Co., Willans and Robinson.

Diploma of Honour and Gold Medal (highest award).—Brush Electrical Engineering Co., Crompton and Co., Edison and Swan United Electric Light Co., Johnson and Phillips, Siemens Brothers and Co., Limited.

Gold Medal.—Coxeter and Son, Davey, Paxman, and Co., Easton and Anderson, Electric Construction Corporation, Electrical Power Storage Co., W. T. Glover and Co., W. T. Henley's Telegraph Works Co., the Laing, Wharton, and Down Construction Syndicate, Nalder Brothers and Co., Saxby and Farmer, J. White.

Silver Medal.—Acme Electric Co., R. Anderson and Co., J. E. H. Andrew, J. D. F. Andrews and Co., Armstrong's Glass Co., Barclay and Son, Benham and Frond, L. Bristol, Britannia Rubber and Kamptulicon Co., British Gas Engine Co., British Stone and Marble Co., Browett, Lindley, and Co., Campbell Gas Engine Co., Chubb and Son, Consolidated Telephone Co., Davis and Timmins, Day and Co. (Bath), Dent and Co., Dick, Kerr, and Co., Edison Manufacturing Co., Epstein Accumulator Co., Ferranti, Limited, Fielding and Platt, Fowler-Waring Cables Co., General Electric Co., F. Giles and Co., W. Groves, L. A. Groth, Gulcher Electric Light and Power Co., W. J. Hammer, H. F. Joel and Co., Laing, Wharton, and Down, Lloyd and Lloyd, London Metallurgical Co., Mosses and Mitchell, Osler and Co., Rashleigh Phipps and Dawson, Richard Frères, F. M. Richards, Ronald A. Scott, Shirley and Co., Trent Gas Engine Co., J. L. Warby, Waygood and Co., Wells Brothers, Western Electric Co., Weymersch Battery Syndicate, Woodhouse and Rawson.

Bronze Medal.—Allsop and Co.; Anders, Elliot, and Chetham Strode; Appleton, Burbey, and Williamson; Archer Pipe Co., Becker and Co., W. J. Bishop, G. Bowron, Burnby and Son, Capitaine Gas Engine Co., Charlesworth, Hall, and Co., H. and J. Cooper, Croggon and Co., Dorman and Smith, Electric Stores, Limited, Faraday and Son, Fowler, Lancaster, and Co., W. J. Habgood, E. S. Hindley, Hookham, Townley, and Co., Homacoustic Speaking Tube Co., International Electric Co., T. Jenner, G. Jennings, A. Jooss, Lacombe and Co., J. Lewis, A. P. Lundberg, Maquay Electric Light Syndicate, H. Mayer, Mining and General Electric Lamp Co., Napier and Son, F. M. Newton, J. Riedel, Roberts, Adlard, and Co., Roper's Electrical Engineering Co., Samuel Smith and Son, Edward Spencer and Co., J. Spencer, G. Stegmann, Taylor and Tucker, Telegraph Manufacturing Co., Harry Thorpe, H. S. Tipping, "Trusty" Engine, Wilson Hartnell, Ziety and Co.

LETTERS TO THE EDITOR.

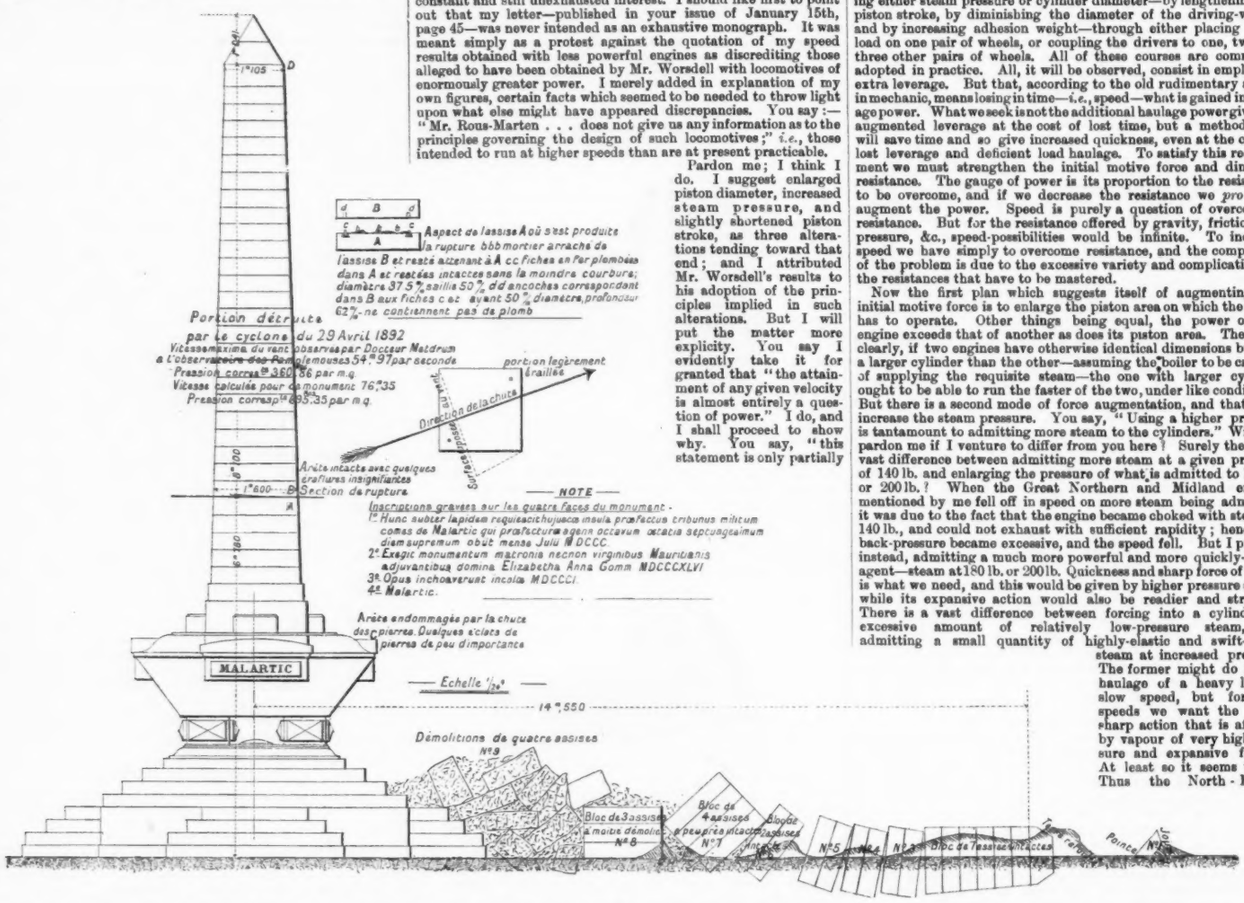
(We do not hold ourselves responsible for the opinions of our correspondents.)

CYCLONE WIND PRESSURES.

SIR,—The following is a curious instance of destruction caused by the wind during the cyclone which swept over the island of Mauritius on the 29th of April last. The wind was extremely violent, and the barometer fell to 27·99in., or 711 mm. I should be obliged if you would lay the case before your readers, in order to elicit their views as to the proper method of calculating the pressure of the wind and of deducing therefrom its velocity.

At the upper end of the amphitheatre of hills in which the town of Port Louis stands, there is an open space called the Champ de Mars. This space is nearly square. Standing at the opposite end of this field to which the wind blew is a monument known as the "Tombeau Malartic." In the drawing I send you herewith I have omitted useless details and given only the principal dimensions. It will be seen that the upper part of the obelisk has been blown over by the wind and thrown to the ground. It will be noticed in the drawing that the block No. 1 on touching the ground must have travelled horizontally from left to right. This is shown by the earth having been heaped up on the right side. I have not been able to ascertain how far the fallen part has slid along the ground.

At first sight it appears as though the fallen portion of the obelisk had rotated around the corner A as it fell, but if this had been so the corner A would have been badly damaged, but as a fact it is only slightly chipped. On the other hand, the angle C is broken in such a way as could only have been caused by the impact of the stones forming the four courses marked 9; each course of the overturned part is composed of four corner stones and of two or four stones—according to the size of the course—which complete the square; these stones are as a rule 355 mm. broad; the hearting consists of rubble bedded in mortar. All the large stones of each course are bound together by cramps made of 20 mm. square iron. The mortar is of lime and sand. The sand is obtained from the seashore, and consists of dead shells reduced to powder; this mortar is very adhesive in the present case, and is hard and not easily broken up. The stone is hard blue basalt of a density of 2·75; to estimate the density of the hearting I have taken the mean between that of the mortar 1·70 and that of the stone, or say 2·22. Taking these figures, I have calculated that the weight of the fallen part must be about 40,000 kilos.


Portion détruite
par le cyclone du 29 Avril 1892
Vitesse maxima du vent observée par Docteur Meldrum
à l'observatoire des Pamplemousses 54.m 97 par seconde
Pression correspte 360.36 par m.q.
Vitesse calculée pour ce monument 76.m 35
Pression correspte 695.35 par m.q.
Aspect de l'assise A où s'est produite
la rupture bbb mortier arraché de
l'assise B et restés attenant à A cc fiches en fer plombées
dans A et restées intactes sans la moindre courbure;
diamètre 37.5% saillie 50% dd encoches correspondant
dans B aux fiches c ez ayant 50% diamètre profondeur
62%-ne contenant pas de plomb
Direction de la chute
Surface primitive du sol
Arête intacte avec quelques
traces insignifiantes
Section de rupture
NOTE
Inscriptions gravées sur les quatre faces du monument -
1° Hunc subter lapidem requiescit hujusce insulæ præfectus tribunus militum
comes de Malartic qui prælecturæ agens octavum ætatis septuagesimum
diem supremum obiit mense Julii MDCCC.
2° Exegit monumentum matronis necnon virginibus Mauritianis
adjuvantibus domina Elizabetha Anna Gomm MDCCCXLVI
3° Opus inchoaverunt incolæ MDCCCI.
4° Malartic.
Arête endommagée par la chute
des pierres. Quelques éclats de
pierres de peu d'importance
MALARTIC
Echelle 1/50
14.m 550
Démolitions de quatre assises
N°9
Bloc de 3 assises
à moitié démolies
N°8
Bloc de
4 assises
presqu'intactes
N°7
Bloc de 3 assises intactes
N°5
N°4
N°3
Bloc de 1 assise intactes
Terre rapportée
Pointe
N°1

To strengthen the obelisk the builder has fitted round iron dowels on the opposite corners of each course. I do not consider that these dowels have increased the strength of the monument; at any rate, at the point of rupture they are uninjured and not even bent. This proves that the courses have not slid on each other. This view is strengthened by the fact that the mortar torn from the lower side of the course B still adheres to the upper side of course A. This mortar overlaps the edge by 20 or 40 mm. It would thus appear that the upper part of the obelisk was first lifted and then thrown to the ground. The point D after the block had turned on the edge A should lie on the ground at a distance of 8·90 m. from the vertical centre of the building, instead of which it lies in reality at 14·55 m. from that centre; the block in falling has therefore received an impulse which has carried it 5·65 m. further than it should have gone had it fallen quietly.

The centre of the thrust of the wind must nearly coincide with the centre of gravity of the fallen mass, its shape being symmetrical. I assume also that the wind blew horizontally. Taking the moments of these two forces in connection with the edge A, I find that to disturb the equilibrium of the fallen mass a total wind pressure of 9543 kilos. was required. The surface exposed to the action of the wind was 13·72 square metres.

Taking the formula $P = K \times 2 \times S \times h$, and making

$P = 695{\cdot}35$ kilos.,
$S = 1$ square metre.,
$K = 1{\cdot}17$, weight of 1 cubic metre of air at 25 deg. C.,
$= \frac{V^2}{2g}$,

we have V (velocity of the wind per second) = 76·35 m. = 170·82 miles per hour.

Doctor Meldrum, director of our observatory, gives the results of observations on the velocity of the wind, and states that the highest mean recorded for any one hour's observations during the cyclone was 112·5 miles, or 50·26 m. per second. He has informed me, however, that for some seconds he recorded 123 miles per hour, or 54·97 m. per second; but judging from the damage done by the wind in the vicinity of the observatory, it was not so violent there as it was near the Tombeau Malartic.

In the foregoing calculations I have taken no account of the adhesion of the mortar, as I take it to be of small importance, nor have I considered the weight of the rain, which at the time was falling in great abundance. It seems to me, however, that the latter must have played an important part. It was so dense that it appears as a thick veil, preventing you from distinguishing objects more than 50 m. or 60 m. away. I observed, moreover, that in each squall the rain, in striking against a wall, fell to the ground in heavy sheets. This water would probably act on exposed surfaces by its momentum. You will receive a photograph by next mail, arriving about the 3rd of July.

RIGIS DE CHAGNE, C.E.

Forges et Fonderies de Maurice, Port Louis,
Ile Maurice, May.

HIGH-SPEED LOCOMOTIVES.

SIR,—In your leading article of January 15th you were good enough to invite me to state more fully my views on the subject of high-speed locomotives. I have much pleasure in responding to your courteous invitation. I regret that an unaccountable delay in the arrival of my copies of THE ENGINEER since December has made my response somewhat late. However, the subject is one of constant and still unexhausted interest. I should like first to point out that my letter—published in your issue of January 15th, page 45—was never intended as an exhaustive monograph. It was meant simply as a protest against the quotation of my speed results obtained with less powerful engines as discrediting those alleged to have been obtained by Mr. Worsdell with locomotives of enormously greater power. I merely added in explanation of my own figures, certain facts which seemed to be needed to throw light upon what else might have appeared discrepancies. You say:—"Mr. Rous-Marten . . . does not give us any information as to the principles governing the design of such locomotives;" *i.e.*, those intended to run at higher speeds than are at present practicable.

Pardon me; I think I do. I suggest enlarged piston diameter, increased steam pressure, and slightly shortened piston stroke, as three alterations tending toward that end; and I attributed Mr. Worsdell's results to his adoption of the principles implied in such alterations. But I will put the matter more explicity. You say I evidently take it for granted that "the attainment of any given velocity is almost entirely a question of power." I do, and I shall proceed to show why. You say, "this statement is only partially true." If so, the shortcoming from absolute truth consists only in under-statement—in the word "almost." For I am prepared to contend that the question is entirely one of "power," as I understand and use the term.

I define "power" as the force which overcomes resistance. But there are two main classes of power. There is (*a*) the initial motive force, and there is (*b*) the mechanical appliance of leverage which multiplies the effect of that force at the cost of a greater expenditure of time. The first (*a*) is found in the steam pressure, and it is gauged by the amount of that pressure and by the piston area upon which it operates. The second (*b*) is measured by the length of the piston stroke and the relative diameter of the driving wheel. I neglect, as non-essential to my argument, the two other factors at the extreme ends outside of these, viz., the boiler-power on the one hand and the adhesion weight on the other. I take it for granted that no modern locomotive designer would supply inadequate boiler-power, and, in fact, during my English experiments I never found any material shortness of steam, not even in the much-abused 19in. cylinder Midland engines, excepting on one single occasion. I was struck with the diversity of practice with respect to heating surface. Why the Great Western broad-gauge engines should have, in round figures, 2000 square feet, the London and North-Western "Dreadnoughts" and London, Brighton, and South Coast "Gladstones" 1500ft., the Midland 1667 class 1121ft., and the South-Eastern 19in. class only 1020ft. for virtually identical work was never clearly explained to me, but the fact remained that these very different boilers seemed alike in being always equal to every requirement. It struck me as odd that those critics who condemned the Midland engines for having only 1121 square feet of heating surface should praise the South-Eastern engines with precisely similar cylinder dimensions and wheel diameter, but only 1020ft. of heating surface. That, however, was only one of many seeming inconsistencies which met me during my English visit. Adhesion weight, too, appeared to be always adequate. The four doubtful speed factors are steam pressure, cylinder diameter, piston stroke, driving wheel diameter. With these, therefore, I shall specially deal.

But again I must take exception to your assumption that I suppose the engines to be always "loaded in proportion to their powers," and that I presume an engine of double power to be loaded double. Not at all. Quite the contrary. I suppose the extra power of a stronger engine to be utilised in obtaining increased speed without increased load. For instance, the Great Northern engine that attained eighty miles an hour with a light load could only reach seventy-four when the load was increased on the same gradient. I take a typical load—let us say the seventy-six tons which I learn from Mr. Webb was that of the West Coast Scotch racing train in 1888, and is that of the daily up Manchester special express on the Great Northern. If the Great Northern 8ft. wheel engine can touch eighty miles an hour down a long gradient with that load in specially favourable circumstances, what conditions—what change in the construction of the engine—would be needed to enable the alleged North-Eastern speed of eighty-six miles an hour to be feasible with the same light load? That is the problem as I put it, and intended to put it. I expressly said that the enormous load said to have been hauled at eighty-six miles an hour on the level by the North-Eastern compound made it difficult for me to accept the statement at all as free from error. It was the load, and not the speed, that presented the difficulty to me, and it is the latter point alone that I am discussing. You have said that I "give no sufficient indication why some engines move faster than others." I am not sure that they do when tested under exactly similar conditions with proportional loads. But the conditions must needs include dimensions giving adequate capacity for overcoming resistance of whatever kind—internal or external. So we get back to the old problem after all.

I cannot pretend to deal exhaustively within the limits of this letter with the vast question of resistance, which you have several times so ably discussed in your leading columns. I must content myself on the present occasion with generalising it as internal and external resistance. Now, assuming that the resistance to be overcome is that offered by the haulage of a heavy load at moderate speed, the extra "power" might be obtained—without augmenting either steam pressure or cylinder diameter—by lengthening the piston stroke, by diminishing the diameter of the driving-wheel, and by increasing adhesion weight—through either placing more load on one pair of wheels, or coupling the drivers to one, two, or three other pairs of wheels. All of these courses are commonly adopted in practice. All, it will be observed, consist in employing extra leverage. But that, according to the old rudimentary axiom in mechanic, means losing in time—*i.e.*, speed—what is gained in haulage power. What we seek is not the additional haulage power given by augmented leverage at the cost of lost time, but a method that will save time and so give increased quickness, even at the cost of lost leverage and deficient load haulage. To satisfy this requirement we must strengthen the initial motive force and diminish resistance. The gauge of power is its proportion to the resistance to be overcome, and if we decrease the resistance we *pro tanto* augment the power. Speed is purely a question of overcoming resistance. But for the resistance offered by gravity, friction, air pressure, &c., speed-possibilities would be infinite. To increase speed we have simply to overcome resistance, and the complexity of the problem is due to the excessive variety and complications of the resistances that have to be mastered.

Now the first plan which suggests itself of augmenting the initial motive force is to enlarge the piston area on which the steam has to operate. Other things being equal, the power of one engine exceeds that of another as does its piston area. Therefore clearly, if two engines have otherwise identical dimensions but one a larger cylinder than the other—assuming the boiler to be capable of supplying the requisite steam—the one with larger cylinder ought to be able to run the faster of the two, under like conditions. But there is a second mode of force augmentation, and that is to increase the steam pressure. You say, "Using a higher pressure is tantamount to admitting more steam to the cylinders." Will you pardon me if I venture to differ from you here? Surely there is a vast difference between admitting more steam at a given pressure of 140 lb. and enlarging the pressure of what is admitted to 180 lb. or 200 lb.? When the Great Northern and Midland engines mentioned by me fell off in speed on more steam being admitted, it was due to the fact that the engine became choked with steam at 140 lb., and could not exhaust with sufficient rapidity; hence the back-pressure became excessive, and the speed fell. But I propose instead, admitting a much more powerful and more quickly-acting agent—steam at 180 lb. or 200 lb. Quickness and sharp force of action is what we need, and this would be given by higher pressure steam, while its expansive action would also be readier and stronger. There is a vast difference between forcing into a cylinder an excessive amount of relatively low-pressure steam, and admitting a small quantity of highly-elastic and swift-acting steam at increased pressure. The former might do for the haulage of a heavy load at slow speed, but for high speeds we want the quick, sharp action that is afforded by vapour of very high pressure and expansive faculty. At least so it seems to me. Thus the North-Eastern engine, with 20in. cylinder and 200 lb. of steam, ought, *cæteris paribus*, to beat the Great Northern engine with 18in. cylinder and 140 lb. of steam, so far as speed is concerned. And Mr. Worsdell gives figures to prove that it has done so.

The increased motive force has its work cut out in overcoming outside resistance. The chief internal resistances which have to be mastered are probably two—back pressure and friction. The former has long been a *crux* to engineers. I venture to think, however, that its ill effects will be found to be smaller when higher pressure steam is used—paradoxical as this may appear, *primâ facie*, and otherwise it can only be lessened by some marked improvement in the provision for exhaust. The obstacle of friction at high speeds can be variously managed. In my former letter I advocated a comparatively short piston-stroke—one not exceeding 24in.—with the object of diminishing piston speed, which means friction. It may perhaps be retorted that the engine which attained the maximum speed in my experience—the Great Northern 8ft.—had the longest piston-stroke of any English locomotive, viz., 28in. That would be quite true and just, but it would not touch my argument which is rejecting the possibility of attaining greater speeds than that reached by the Great Northern engine. Further, it is my personal opinion that if that engine had had cylinders 22 by 24, instead of 18 by 28, she would have been able to run considerably faster, and that had her steam pressure been augmented from 140 to 200 lb., the gain would have been still greater. The larger piston diameter and steam pressure would have enabled external resistance to be more easily overcome, and the reduced length of stroke would have diminished piston speed and friction. I do think, as you say, that "the momentum and inertia of the reciprocating portions of the engine are important factors," and nobody who has made careful observations on an engine at extreme speeds can doubt that this is so. The slower the motion of the working parts the smaller is necessarily the friction. The vibration caused by the motion of heavy coupling-rods is excessive, and this means additional friction. I noticed it especially when trying a six-coupled engine with 4ft. driving-wheels at speeds of fifty-five to fifty-nine miles an hour. With the object of diminishing excessive speed of reciprocating parts, vibration, friction, and other internal sources of resistance, I advocate single driving wheels of large diameter with a relatively short piston-stroke. I believe that if these were combined with high steam pressures and

large cylinder diameter the typical engine would be produced for the attainment of extreme speeds with moderate or light loads. If a heavy load has to be hauled at a like velocity this, if possible at all, can only be done by an enormous enlargement of the initial motive power. Hitherto designers have been content to compromise by pulling their bigger loads at a somewhat lower speed, with the aid of augmented leverage through increased length of piston stroke, decreased diameter of driving wheels, and the use of coupling-rods.

I have endeavoured as briefly as I could to express the views on this subject which my personal study of the subject and experience in practice have led me to form. I do so with considerable diffidence in response to your courteous invitation, and I hope that the result may be a discussion tending to the beneficial elucidation of an important and interesting problem.

Wellington, N.Z., May 17th. CHARLES ROUS-MARTEN.

THE GREAT WESTERN RAILWAY.

SIR,—The interesting details of the conversion of the remaining broad gauge lines of this company into narrow gauge were fully chronicled by you. I therefore ask your permission to make a comparison of the time taken on the journey between London and Plymouth and Penzance now—July, 1892—and a year ago—July, 1891—by the more important trains.

Down trains, July, 1892.

Paddington	5.30	9.0	10.15	11.45	1.15	3.0	5.0	9.0
Plymouth arr. } .. Millbay }	1.5	4.50	3.53†	6.5	7.50	9.10	12.20	4.45 B
Penzance arr... ..	6.25	—	7.15	9.30	—	—	—	8.0

Down trains, July, 1891.

Paddington	5.30	9.0	10.15	11.45	1 0	3.0	5.0	9.0
Plymouth arr. } .. Millbay }	12.35†	4.30	3.56†	5.55	7.30	8.55	12.10	4.27
Penzance arr... ..	3.40	—	6.57	9.0	—	—	—	7.35

Up trains, July, 1892.

Penzance	—	6.5 (A)	7.45	10.45	—	—		4 30
Plymouth } .. Millbay dep. }	8.35	10.25	11.45	2.5	2.15	3.50		8.3 B
Paddington	2 53	6.0	6.30	7.45	8.25	10.3		4 0

Up trains, July, 1891.

Penzance dep.	—	6.25 (A)	8.5	11.10	—	12.45		5.0
Plymouth } .. Millbay dep. }	8.35	10.35	11 50	2.10†	2.20	4.0		8.23
Paddington arr. ..	2.45	6.0	6.30	7.50	8.10	10.0		4.0

† North-road, no connection out of or into Millbay.
A. Mondays only.
B. The mails to and from Cornwall do not run into Millbay, but give connections in and out.

So far from having been attended with beneficial results, it will be observed that every train almost now takes longer on the narrow gauge than it used to on the broad gauge metals. Again, Penzance now receives its letters half an hour later than last year, and similarly has to post its letters half an hour earlier, though neither night mail now, as formerly, goes into Millbay. Can any of your readers explain this state of affairs? Is the object to show the superiority of the broad gauge? E. B. D.

London, July 4th.

BRAKE HORSE-POWER.

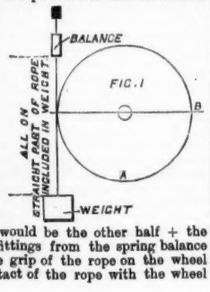
SIR,—We certainly had no intention of taking part in this new discussion on brakes, which has been started in your columns by "C. E. B.," but your remarks in last week's paper leaves us no option. You have either found or lost some 17 brake horse-power, and ask us where it is.

We have read your remarks very carefully, and we are also aware that you have had a wide experience in engine testing; but, judging from what you say about the lost 17 brake horse-power, it would appear that you have not spent much of your time in training new engines preparatory to official tests, or you would certainly have first looked in the most likely place to find the lost brake horse-power, viz., friction in the engine, or, in other words, the power lost between the pistons and the fly-wheel rim. In a new engine this is a very variable amount.

It is our custom to contract for engines and boilers, and guarantee economy, both of water and coal. For obvious reasons we prefer indicated horse-power as a basis to work upon, but in the contract for the Oxford engines brake horse-power was the basis of the tests: consequently, the engines had to be well run to bring up the mechanical efficiency before the official test, which took place on the 21st of January. In all cases we have the tests made before the engines leave our works. We are aware that we could get better results, especially on brake horse-power basis, if we tested the engines after they were bolted down on their permanent foundations; but, on the other hand, we have all the appliances and the men here, and can therefore conduct the tests at less expense before the engines leave the works. These engines during the tests were set on packings 2ft. above the shop floor, and were not bolted or spiked down in any way, the outer bearings being carried on separate packings, leaving a pit for the fly-wheel. Under these conditions we were quite prepared for a low mechanical efficiency to start with, and we got it. You will observe that it was on the 19th of January that we got the somewhat low efficiency of 77·67 per cent., but by running the engines almost continuously for forty-eight hours, the efficiency rose to 87·35 per cent. on the official test, which took place on January 21st. Now, to anyone accustomed to training engines—especially when fitted up in a temporary manner—there is nothing curious about this increase of efficiency, in fact it is the very thing one looks for and expects to find; and in this case we found 17-horse power which you appear to have lost, but we did not look in the jackets or the brake for it. At the same time it is not impossible that a small percentage of the increased efficiency may have come from both these sources, but the great bulk was no doubt taken from the internal friction of the engines.

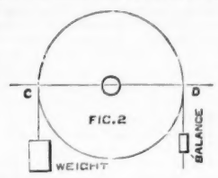
With your permission we wish to take part in the discussion on the "tail rope" brake, and that is our reason for writing that last paragraph about the small percentages, &c. We may state that you are wrong in supposing that the lubrication of the rope was in any way changed during the two tests published, in both cases tallow was used. You must remember this was not a case of taking off 20-horse power or 30-horse power, which can be done with a dry rope; we had to provide for 200-indicated horse power, and we find that tallow very much increases the grip of the rope on the wheel, and prevents the rope from burning.

Now with respect to the difference in the load on the brake and the pull on the spring balance during the two tests, we give the following particulars. On the first test the rope was new and not bedded to the wheel, and to get sufficient grip had to be taken all round the wheel as shown in Fig. 1, which is the common practice. After running some time, the rope got properly bedded to the wheel, and the grip increased until the rope sagged down and left the wheel at A. So we may say it practically did not touch the wheel from leaving the spring balance till it reached B. Therefore the pull on the rope at B would be, roughly speaking, one half the weight of the bight of the rope hanging below the centre line.



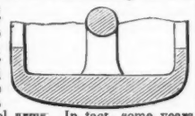
The pull on the spring balance would be the other half + the weight of the straight part and fittings from the spring balance down to the centre line. As the grip of the rope on the wheel increased or decreased, so the contact of the rope with the wheel moved from A to B or from B to A. This was all duly noted at the time, and judging from the discussion that took place among our staff on the subject, we think there is plenty of material for your mathematical correspondents to work upon for the remainder of this year, as they appear to make but slow progress.

Before the official test on January 21st this brake was altered by us as shown in Fig. 2, the rope being accurately balanced on each side of the wheel, and in contact with the whole for half its circumference, namely, from C to D.



The rope used was a flat rope, 6in. wide, made as shown in Fig. 3. For about 3ft. up from the weights it was left intact. After that it was split into three ropes, to allow them to bed to the wheel and let out heat, and admit of lubrication. The fly-wheel rim is cast trough section. Cold water was run in continuously, and the warm water skimmed

out in the same manner as the cream is taken out in a cream separator. We believe that this system of brake cooling was first introduced by Mr. Druitt Halpin, and is certainly a much better arrangement than allowing the water to evaporate out of the rim, for when a large amount of power is taken off with the latter method of cooling the clouds of steam are very objectionable, and there is a great risk of breaking the fly-wheel arms. In fact, some years ago we had the arms of a wheel broken before the heat got up to the evaporating point. There is not much risk with small wheels and thin rims.



If you had taken the trouble to inform yourself of the conditions under which the two tests were made, you would have seen that it was impossible to test the value of the steam jacket by the brake horse-power. The indicators are nearer the seat of war. Why not take the indicated horse-power as a basis, as we have done?

J. AND H. MCLAREN.

Midland Engine Works, Leeds,
July 5th.

[Messrs. McLaren are scarcely fair. The trials of their engine were carried out by Professor Goodman, Mr. Wilson Hartnell, and Mr. Watson ostensibly with great care and minute attention to accuracy. There was nothing said to raise the suspicion that the trial of January 19th was merely an ordinary shop run, intended to get bearings, &c., into order. Why call in Professor Goodman and Mr. Wilson Hartnell and Mr. Watson to report on such a trial? The information supplied by Messrs. McLaren, however, concerning the brake used is very interesting, but leaves us yet in doubt. We still think that Messrs. McLaren have over-estimated the internal resistances of their engine, and under-estimated the imperfections in the brake, as used on their first run.—ED. E.]

SIR,—I am not in the least surprised to see that your correspondent "Tester" has found out that rope brakes working with light tail rope pulls give better results than those with heavy tail pulls.

There is a direct flaw in the theory of the tail rope brake, and it is time that attention was directed to it. Let us suppose that we have a brake with a load of 1000 lb. and a tail pull of 10 lb. Then the net load is said to be 990 lb. Now, let us have a load of 2000 lb. and a tail pull of 1010 lb. In theory the load on the engine is still only 990 lb., but no engineer in his senses would imagine that the actual work done by the engine would be the same in both cases. Indeed, the engine could not turn round at all, being gripped too tightly by the rope round the fly-wheel.

Stated thus brutally, so to speak, the defect in theory is at once recognised; but it is not so easy to see that errors may be introduced by using tail pulls in excess of the smallest possible; errors which may amount to several per cent. will thus creep in. If the tail-rope brake is used, then the greatest care should be taken so to arrange matters that the tail pull shall be quite insignificant; and this can always be done by using a hard twisted rope of sufficient size, or two or three ropes if need be, keeping the rope free from the least taint of lubricant and the wheel properly cooled by water within the rim.

For minute accuracy, however, there is nothing that can be applied to a steam engine to compare with a properly-made Prony brake. Where much testing is done, a special fly-wheel or pulley should be kept for the purpose; it can be made to fit any shaft in reason, by the aid of an adjustable or changeable centre.

I note what your correspondent "C. E. B." says about impact in brake action. Mr. Nicholls fails entirely to understand him, and so comes to grief. But the impacts do not occur quite as "C. E. B." supposes, but are due to the inter-collisions of the roughnesses on the rim and the rope or blocks.

In conclusion, I would point out that when a brake jumps, the load on the engine is always augmented. It would take more space than I venture to ask for to explain why. C. T. HANCOCK.

Newcastle-under-Lyne, July 5th.

HYDRAULIC OR JET PROPULSION.

SIR,—It is universally admitted that there are many reasons why a hydraulic propeller would be preferred to a screw or paddle if an economical result could be obtained with it. The greatest loss in efficiency in the hydraulic system or jet propulsion as hitherto applied was due, firstly, to the small area of water acted upon; secondly, to the energy stored in the jets not being utilised; and, finally, to the inefficiency of the pump employed.

To propel a ship efficiently and economically depends greatly on the area of water acted upon in a unit of time, that the water acted upon is kept in a state of rest as much as possible, on the energy and its direction with which the propeller acts upon it, and, finally, that it receives as little sternward velocity as possible.

Rankine told us that if we double the quantity of water acted upon we double the loss from this cause, but if we double the acceleration of the water acted upon, we increase the loss four-fold. S. W. Barnaby says that this fully explains why the hydraulic or jet propeller, which is forced to act upon a small column of water—*i.e.*, in the former application—appears at such a disadvantage when compared with the screw. But it also fully explains why the screw must be considered a most wasteful propeller.

The screw propeller, on account of giving acceleration to the water previous to acting upon it, not only increases the augmentation of the vessel's resistance thereby, but in order to bring any energy upon the already accelerated water, it has to act upon large areas or with a greater or increased energy than the water acquired previous to entering the screw's disc, in order to get reactionary thrust.

In the former application of hydraulic propulsion the nozzles were kept stationary when the vessel was moving on a certain course, and the jets therefore constantly discharged in one line of direction. The area of water acted upon by the pump was only equal to the area of the discharge outlets, consequently very limited. The pump, however, met with considerable resistance in forcing the water through the pipes at a certain velocity, and taking the small area of water acted upon into consideration, the reactionary thrust under the circumstances was most remarkable. Instead, however, of applying the energy of the jet for the purpose of acting upon more water, this power was literally wasted. It made but very little difference whether such jet was discharged in the air or in the water, the result was about the same. If discharged against the water it constantly acted against an area equal to its diameter only, and against water having its own velocity, therefore it was impossible to exercise any thrust against the water.

There are a great many people labouring under the false impression, that no reaction can be derived from a jet. An admiral of the Royal Navy who attended the trials of the Waterwitch and Nautilus said that it made no apparent difference whether we discharged the jet against a stone wall or in the air, the effect was in each case the same, and the gentleman was perfectly right; but in the conclusion he arrived at, that a jet cannot cause reactionary qualities under any conditions, was entirely wrong.

When water issues through the discharge pipe and immediately at its outlets meets with a constant resistance from its constantly impinging upon water in a state of rest, a reaction will make itself apparent at the pump. The pump requires then a greater pressure to pump against, which pressure is brought to bear directly upon the water of floatation, thereby vastly increasing the efficiency of the entire apparatus. This can only be accomplished by giving the discharge pipe two or more outlets, and by revolving such outlets around a common axis. The result is as follows:—If we take two outlets of the aggregate area of one square foot and revolve the same in a circle of 20ft. circumference at three revolutions per second, we will act upon $3 \times 20 \times 1 = 60$ square feet of water. The rotation can be made so rapid that the water acted upon will receive but very slight motion sternward, hence the full energy will be constantly applied against water in a perfect state of rest.

When it is considered that, notwithstanding the drawbacks of hydraulic propulsion as formerly applied, and that the most unsuitable pumps have been used, and notwithstanding that the twin screws of the Waterwitch's sister ship Viper were acting upon fourteen times the area of water as the hydraulic pump of the Waterwitch, it is astonishing this latter vessel did, nevertheless, on one of the trials attain the same speed with the same power as the twin screw vessel Viper of like tonnage. The total area of water acted upon by the hydraulic propeller was only 6·2 square feet; the energy of action or the velocity was 30ft. per second; hence, the resultant was $6\,2 \times 30 = 186$ cubic feet per second. The screws of the Viper acted on about 98 square feet of water. The apparent energy was about 18ft. per second, but as the water must have been accelerated up to 16ft. per second previous to entering the screw, the real energy with which the screw acted upon the already accelerated water could not have been much more than 2ft. per second, which would give nearly the same resultant per second as with the pump. Had the Vogelsang revolving jet system been employed, with outlets of only one square foot area revolving in a circle of 4ft. diameter or 12ft. circumference at five revolutions per second, they would have acted upon $5 \times 12 \times 1 = 60$ square feet of water per second, and this with either a much greater energy with the same power applied or the same energy with greatly less power. If the energy had been the same, the result would have been $30 \times 60 = 1800$ cubic ft. per second with an application of only 170 indicated horse-power, instead of 850 indicated horse-power with an equal result of the twin screws.

That the hydraulic apparatus in the torpedo boats of Thornycroft and Lillihök, of Sweden, did not come up in speed with the propeller was owing entirely to the pump employed. A centrifugal pump or a turbine can only pump against a certain pressure, and when that stage is reached the respective apparatus will simply whirl the water around within the casing, but will not discharge any additional water. Therefore, when it came to the higher speeds in these boats, the pump simply refused to act. The proof of this is most plainly shown in the discrepancies between the circumferential velocity of the pump and the velocity of discharge.

In order to use hydraulic machinery for propulsion efficiently, a pump has to be employed that can force water against a high pressure. As by the Vogelsang apparatus and method of rotating jets and nozzles it does not require more than one-fifth of the power for the same speed as with a propeller, be it screw or paddle, other conditions equal, the space such pumps will take up within the vessel will be comparatively small.

That four-fifths of the power saved means also the saving of four-fifths in coal consumption and bunker space, as well as five times more coal endurance for a war vessel, must become readily apparent. The figures appear almost incredible, but they are true nevertheless, and results of experiments that have been made fully prove their correctness. A vessel going from New York to Queenstown, or *vice versâ*, in four days, or even less, on 50 tons of coal per day, or 200 tons for the trip, is now brought within the reach of possibilities. The facilities for backing and manœuvring will equal, if not outreach everything in existence.

Mr. Ruthven, of Edinburgh, who has so diligently laboured in this field, was right in his prediction, made not long ago, that hydraulic propulsion would supersede the paddle and the screw wherever efficiency and economy are estimated at their true value, and I cheerfully acknowledge that much in my invention of this new method and apparatus is due to the appeal of Mr. Ruthven to engineers and inventors to promote the cause of hydraulic propulsion. ALEXANDER VOGELSANG.

De Keyser's Royal Hotel, London, E.C.,
July 4th.

PROPOSED VARLEY TESTIMONIAL.

SIR,—The following is the report of a meeting held at the Westminster Palace Hotel on the 1st July, for the purpose of discussing the subject of the Varley testimonial. A considerable number of gentlemen were present, including Lord Kelvin, Major Page, Mr. A. Siemens; Professors Hughes, Perry, Sylvanus Thompson, Forbes; Messrs. Gatehouse, Crompton, Stroh, Gorman and others; Lord Kelvin took the chair. A number of letters were read from gentlemen who were unable to attend, but who had signified their hearty assent with the objects of the meeting. Among these were Sir F. Bramwell, Sir H. Mance, Sir Leppoc Cappel, Sir D. Galton, Sir J. Pender, W. H. Preece; Professor Ayrton, Professor Kennedy, Dr. Gladstone, Professor Lodge, Professor Fitzgerald, J. W. Swan, Messrs. Belshaw, J. E. H. Gordon, Manville, Massey, R. K. Gray, Jackson and Goolden.

Mr. Gatehouse then gave a very interesting account of Mr. Varley's life, and the services that he has rendered to electrical engineering. After some remarks by Mr. Crompton, Major Flood Page and Mr. Siemens, the following resolution was put and carried: "That this meeting approves of a testimonial being got up on behalf of Mr. S. Varley, that the whole of these gentlemen who have given their names as willing to serve on the committee, be and are hereby appointed a committee to act in the question of the Varley testimonial, and that an executive committee be hereby appointed, consisting of Lord Kelvin, Professor S. Thompson, Professor Perry, Mr. A. Siemens, and the gentlemen who attended the preliminary meeting."

Among other matters it was suggested that the aid of the Institute of Electrical Engineers be sought to ask that the Government should grant a pension to Mr. Varley, and further that a statement setting forth what Mr. Varley has done should be prepared by Messrs. Siemens, Gatehouse, Sylvanus Thompson and Crompton, and that this statement should be circulated as widely as possible among members of the electrical profession at home and abroad. That the general committee should consist of the names of the gentlemen who had attended the preliminary meeting, also

those who had attended that day, and all the gentlemen who had written expressing their sympathy with the objects of the meeting, and that every effort should be made to extend the list.

Mansion House Buildings, R. E. CROMPTON.
London, E.C., July 5th.

THE PADDLE STEAMER KOH-I-NOOR.

THE Victoria Steamboat Association (Limited), of London, have made an important addition to their long distance excursion steamers in the production by the Fairfield Shipbuilding and Engineering Company, Glasgow, of the swift and handsome paddle steamer Koh-i-Noor, which went upon her official trials at Wemyss Bay on the Clyde, not long since.

The Koh-i-Noor is of steel throughout, and is 310ft. long, 58ft. broad across her paddle-boxes, 32ft. moulded breadth, and 11ft. moulded depth to main deck. Our illustrations afford an idea of the appearance of the vessel when afloat, and at the same time show the detailed arrangements of both her hull and machinery. She is a remarkable steamer in many important respects, for not only is she the swiftest of her type, but she is also one of the safest, if, indeed, not absolutely more thoroughly guarded against the risks of navigating a busy river thoroughfare than any other pleasure steamer afloat. Certain it is that she is the first river steamer constructed with a bulkhead sub-division and strengthening, in accordance with the recommendations of the Bulkheads Committee. To such an extent has this been done that the first-class dining saloon has actually been divided into two portions by a steel watertight bulkhead; communication between the two being afforded by means of a watertight door, which, upon an emergency, can be instantly closed with the aid of gearing on the deck above. Any persons shut in the aftermost division of the saloon can escape to the deck by means of a trunk staircase which is always kept open. The Koh-i-Noor is therefore practically unsinkable, and the satisfaction afforded to passengers by a knowledge of this important fact must inevitably make her popular with excursionists.

Safety against a common form of accident having been provided for, it next became necessary to fit her so that she may be promptly and easily handled. For this end the Koh-i-Noor has both bow and stern rudders, and thus she may be promptly and safely turned in narrow channels either when going ahead or astern. The stern rudder is worked by means of a steam steering gear fitted on the engine platform, and the bow rudder is provided with a screw steering gear, and the usual locking pins. A steam windlass with capstan is fitted forward to work the cables and moorings; and on the main deck aft abaft the saloon a neat steam capstan is placed for working the mooring ropes there also. In this way time will be saved when stopping at the various piers, besides affording additional facilities for turning the vessel round and warping her in a narrow harbour. The funnels and masts are of course fitted so that they may be lowered, to enable the steamer to pass under London Bridge when proceeding to or from Old Swan Pier, the work being done by small steam winches provided for the purpose.

The fittings and decorations for the convenience and enjoyment of passengers next claim attention. The object sought in this and other features of the vessel has been to beat everything of the same description already existing, and it is only right to admit that a very large measure of success has been attained. Upon the main deck, before and abaft the machinery, there stand two roomy and luxurious deck saloons; the promenade deck being above them, extending about 100ft. in length fore and aft, and the full breadth of the vessel. The two deck saloons provide accommodation for both classes of passengers in the event of rain, and consequently there will be no stifling crushes so often experienced in excursion steamers when the sheltered accommodation above deck is more limited. Standing upon the promenade deck are two deck houses, one amidships and a smoking saloon aft. The midship house has a private cabin, framed in richly marked mahogany, upholstered in scarlet morocco, and richly furnished and decorated. In the same deck house are the captain's cabin, purser's room, ticket office, and a post-office after the style of the Clyde Columbia, where letters, telegrams, and parcels may be handed in for despatch at the various places of call. Above the midship deck house is the navigating bridge, with the usual telegraphs to engine room, mooring stations, bow rudder and windlass.

Returning to the deck saloons we find that the one for the use of first-class passengers is abaft the machinery. The entrance, staircase, and interior are framed, as already remarked, with polished mahogany; the floor is laid with Brussels carpets, and the seats are upholstered in velvet, while the panels at the ends of the saloon are fitted with large bevelled glass mirrors and hand-painted white wood panels. The private state-rooms, of which there are three, and the ladies' boudoir, which is situated at the after end of the saloon, are elegantly fitted. All the ceilings are lined and panelled in white enamel, relieved with gold. Abaft the machinery, the space below deck is entirely occupied with the first-class dining saloon, pantry, bar, and a private room. Both here and in the smoking saloon, at the after end of promenade deck, the deck is laid with alternate planks of teak and yellow pine, which produces a very pleasing contrast. The sides of the dining saloon are decorated with hand-painted panels, and the seats, sofas, and cushions are in scarlet morocco; the side-lights being hung in curtains of brocade. It should be remarked that dining accommodation is provided for 150 persons.

Second-class passengers occupy the forward portion of the promenade deck and the whole of the forward deck saloon; moreover, they are also provided with separate smoking and refreshment-rooms. In fact, the second-class accommodation closely resembles that in the more expensive quarters of the steamer. The dining saloon forward is finished in white enamel, the seats are covered in carriage rep, and merino curtains are hung at the ports. The deck saloon is of polished teak, and is supplied with a bookstall and a coffee buffet. The Koh-i-Noor is thoroughly ventilated throughout by means of exhaust and inlet ventilators, which maintain a constant current of air. Installations of electric light and bells have been fitted, and special features of the electric illumination are the embarkation lamps at the gangways, to give light to passengers landing at night. The hull has been built under the supervision of the Board of Trade, and the full complement of life-saving appliances required by Parliament is of course provided; including a lifeboat, kept hanging at the davits for instant use in an emergency.

The engines of the Koh-i-Noor—shown by our illustration—are of the compound diagonal surface-condensing type, the cylinders, which are 45in. and 80in. in diameter, being placed side by side, and working on two cranks, set at an angle of 90 deg. with each other. The length of stroke is 66in. Each cylinder is fitted with a flat slide valve, worked by the usual double excentrics and link motion. The crank and paddle shafts are of mild steel, and the two paddle wheels, which are entirely of steel, are constructed on the feathering system with curved floats. A cylindrical condenser is placed between the cylinders and the supports for the crank shaft, the condensing water being supplied by a centrifugal circulating pump, worked by a separate engine. Steam is supplied by four Navy-type steel boilers, each having three corrugated furnaces, and the working pressure is 120 lb. per square inch. There are no forced-draught appliances fitted, but a fan for creating an augmented natural draught when atmospheric conditions render it desirable. The result of a mean of several runs on the measured mile showed a speed of no less than 19½ knots.

Mr. R. Saxon White, the manager of the shipbuilding department at Fairfield, who designed the Koh-i-Noor, stated after the trial that she had proved herself to be the fastest river steamer afloat; and if his remarks are limited to what are strictly and truly steamers for river navigation only, there can be no doubt of the accuracy of the statement.

The engines, which were designed by Mr. A. Laing, the manager of the engine department at Fairfield, are an excellent job, and quite in keeping with the traditions of the old Govan establishment.

It is to be regretted that in making her run from the Clyde to the Thames the Koh-i-noor was accidently driven on the rocks near Milford Haven during a fog. So serious was the damage she thereby sustained that in all probability she would have sunk were it not for her splendid bulkhead subdivision. She has consequently been sent back to the Clyde, where a new bow has been built, and a great many other repairs effected upon her by the Fairfield Company. Notwithstanding the great speed with which the work was done, the Koh-i-noor was a month late in starting upon her regular duties on the Thames. The loss thereby inflicted upon her owners was necessarily very serious, but it is to be hoped that they will find ample compensation for this in the popularity she will soon establish for herself now she is regularly running to and from Harwich and Clacton.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

WITH the country now in the thick of the Parliamentary elections, and with the quietude which is usually experienced the week previous to the quarterly meetings, it is not to be expected that much new business will be forthcoming. A quiet tone characterised the markets alike at Birmingham to-day—Thursday—and at Wolverhampton yesterday. At the same time the inquiries which were received showed that stocks in consumers' hands are low, alike of crude and finished iron, and this gave rise to anticipations of a fair amount of new business being forthcoming at next week's quarterly meetings.

Satisfaction was expressed by many business men at the election on Tuesday for Wolverhampton West of that well-known iron and steel master, Sir Alfred Hickman.

The recent decision to hold the forthcoming quarterly meetings in the Exchange as usual, instead of repeating the experiment of holding them in the Town Hall, is generally regarded as a prudent step, and as calculated to facilitate business.

It is not anticipated that these gatherings will develope any important alterations upon the present trade position. A rather better demand than at present is expected for the satisfaction of customers' requirements, which, as intimated above, are considerable; the satisfaction of their wants of late having been mainly of a hand-to-mouth character. No rise is looked for in the price of iron, for the foreign demand is not sufficiently good to warrant such a step, but, on the other hand, it is difficult to see how values can go lower, inasmuch as there is no prospect of much if any further ease this year either in fuel or in wages. The probability seems to be that marked bars will be re-declared at the basis price of £8, at which they have so long stood, and that other classes of iron will also remain unchanged.

Quotations to-day and yesterday did not show any deviation from the figures which have for some time previously been ruling. It was understood that the basis price of marked bars remained £8, and that makers asked about £7 for second grade sorts and £5 12s. 6d. upwards for common.

Galvanised corrugated sheets are quoted about £11 12s. 6d. for doubles f.o.b., Liverpool in bundles. There is still rather more doing than recently with the Argentine Republic and with Chili, and satisfaction is expressed that the relief which for some time past has been needed in the price of spelter has been to some extent afforded by the reduction of the Silesian standard by about £1 per ton. Some consumers of sheets indeed have been endeavouring to turn this circumstance to advantageous account, but manufacturers declare that they cannot afford to sell at any less than current rates; and indeed it is pretty well known that profits just now in the galvanised sheet trade, if they exist at all, are exceedingly meagre.

Engineering sections of iron, such as plates, angles, tees, and the like, are, it is encouraging to note, in good request.

Boiler-plates are quoted £8 upwards, tank-plates £6 10s. upwards, and some descriptions of rods £7. The bridge and roofing makers have been ordering rather better lately of the particular sections of iron which they usually require.

In the bar trade the list houses keep to £8 as the basis price for marked sorts, with the usual 12s. 6d. extra for the Roundoak and a few other brands. Merchant sorts are quoted about £7, and common £5 12s. 6d. upwards. Merchant sorts, in rounds, flats, squares, and other forms, are being ordered in only limited quantities, and specifications for shoe iron are scarcely up to the average. Fire bars, however, are in rather better call. One or two makers are engaged upon Government orders for cable bars. Chain bars are quiet.

Working-up qualities of plain sheets are in fair demand, but galvanising decriptions are of slow sale. Singles are still quoted £6 17s. 6d.; doubles, £7 to £7 5s.; and trebles, £7 17s. 6d. to £8. For hoops, £6 12s. 6d. is asked, and for gas tube strip £6 upwards.

In the crude iron trade some of the Staffordshire and Midland sellers are endeavouring to make capital out of the sharp rise in Middlesbrough iron, but consumers will not respond. The latter consider the Northern position to be temporary, and do not anticipate any lengthened effect upon the local market; though they recognise the importance of the Cleveland position so long as it lasts. Meanwhile Staffordshire all mine hot blast pigs are quoted 62s. 6d., part mines 44s. to 45s., and cinder sorts about 37s., Lincolns are quoted 47s., Northamptons about 44s., and Derbyshires 43s.

In the engineering and heavy iron-foundry trades there continues to be an improvement in the South American demand, and India is also looking up; more particularly for rolled metal, also for tubes, galvanised iron, railway material, and machinery. Until the elections are over and the harvest is fairly within view, not much activity can be looked for in the home trade; but the autumn shipping demand is expected to compensate to some extent for the quietude of the early part of the year, as stocks in foreign and Colonial markets are known to be low.

Australian orders for machinery, engines, and other heavy goods, are still limited; but if the loans proposed by several of the Colonies are satisfactorily placed, some good business may be anticipated.

The old-established firm of Thomas Piggott and Co., gas and general engineers, of Spring-hill and Hooper-street, Birmingham, has been constituted a limited company. The whole of the share capital has been subscribed by the directors and their friends, all the ordinary shares being retained by the partners in the old firm.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The excitement consequent upon the elections is necessarily for the moment to a considerable extent disorganising business operations, and even the very limited transactions which were previously being put through are being still further restricted. For the present there is very little doing really to test the market, buyers showing no disposition to operate beyond covering actual pressing requirements; and even the extremely low prices which in many cases are being quoted for forward delivery apparently offer no inducement. For prompt delivery, makers' quotations for pig iron are for the most part well maintained at late rates; but the belief still prevails that prices will have to be lower, and consequently the policy of holding back as long as possible is being very generally pursued. As I have pointed out, however, in previous reports, the question of costs cannot be overlooked, and must to a large extent govern prices in the immediate future; already both raw and manufactured iron is being placed on the market at an absolute loss to the producer, and until some substantial reduction can be obtained in wages or the price of fuel—of which there is no present prospect—it seems more than likely that the makers and manufacturers of iron will prefer to lessen their production, rather than involve themselves in still more serious loss by forcing sales at still lower prices.

The Manchester Iron Exchange on Tuesday was only moderately attended, and generally only a mere hand-to-mouth business was reported either in pig or finished iron. In some of the district brands of pig iron moderate sales have been made during the last few days, but inquiries coming upon the market on Tuesday were mostly only for very small quantities, and no business of any moment was being done. Lancashire makers quote on the basis of 44s. 6d. for forge to 45s. 6d. for foundry, less 2½, delivered Manchester. Lincolnshire and district brands, although there are still several of the makers who are not really offering in the market at all, are scarcely maintaining firmness at recent quotations, and for delivery equal to Manchester Lincolnshire could be bought at about 43s. 6d. and 44s. for forge to 44s. 6d. and 45s. for foundry, with Derbyshire ranging from 45s. for forge to 48s. and 48s. 6d., less 2½ for the better class foundry brands. In outside brands the present scarcity of Middlesbrough is maintaining a firm tone in quotations for prompt delivery, good foundry qualities averaging 49s. 4d. to 49s. 10d., net cash, equal to Manchester. Forward contracts, however, could be placed at considerably under these figures, but there are practically no buyers except for immediate delivery. Scotch iron remains practically unchanged, and for delivery at the Lancashire ports Govan averages about 45s., Carnbroe 46s., Eglinton 47s., and Glengarnock 48s. 6d., net, prompt cash.

In manufactured iron orders still come forward very slowly, and in very small parcels, which are barely keeping forges going from hand-to-mouth, and prices, if anything, show a weakening tendency. For Lancashire bars £5 15s. is now about the average figure, with North Staffordshire qualities ranging from £5 15s. to £5 17s. 6d, but ordinary merchant sheets remain at about £7 5s. to £7 7s. 6d.; and hoops at £6 6s. for random, to £6 7s. 6d. for special cut lengths, delivered in the Manchester district.

There is also only a very slow business doing in the steel trade; and hematites, if anything, are easier, good foundry qualities not fetching more than 58s. to 58s. 6d., less 2½, with steel billets quoted at about £4 15s., net cash, delivered Manchester. Local makers of steel boiler plates are still firm in holding to special prices for prompt delivery, quoting £7 17s. 6d. to £8 per ton, but forward contracts could be placed at about £7 10s., with steel boiler plates from other districts offering at from £7 5s. to £7 7s. 6d. per ton, delivered to consumers in the neighbourhood of Manchester.

In the metal market business continues in a very unsettled condition, with no orders of any weight going out, owing to the uncertainty as to the course of prices. The tone of the market is weaker, but there is no quoted alteration in list rates for manufactured goods.

The condition of the engineering industries remains very much the same as I have reported for some time past. It is only here and there, in special work, that establishments are securing any real weight of new orders, and generally the reports are that trade is in a very unsatisfactory condition, with contracts running out, and no new work of anything like equal weight coming forward to replace them. The majority of the engineering firms throughout the district are short of orders, and many of them very slack. Boilermakers are not nearly so well off as they were a short time back; locomotive builders are competing very keenly for any new orders giving out, in some instances at prices very considerably below actual cost; and railway carriage and wagon builders have only a moderate amount of work in hand, with an absence of any weight of work at present in prospect.

A generally quiet tone continues to be reported in all descriptions of round coal, and although the better qualities for house fire purposes maintain their price, common coals are, if anything, easier, there being here and there a slight giving way in prices. Four to five days per week represents the full average work of the collieries, but even with this restricted output, stocks are accumulating at many of the collieries, and the supplies of common round coal are considerably in excess of requirements. At the pit mouth best Wigan Arley coal is still quoted at 12s. to 12s. 6d.; Pemberton four feet, and second qualities of Arley, 10s. to 10s. 6d., and common house fire coals, 8s. 6d. to 9s. per ton; but steam and forge coals are rather irregular, and 7s. 6d. to 8s. represent the full prices obtainable for ordinary qualities at the pit mouth. Engine fuel continues in brisk demand, and the lessened quantity of round coal now being screened is producing rather a scarcity in some of the better qualities of slack, with the result that prices are hardening, and in some instances slight advances have been made upon last months rates. At the pit mouth ordinary descriptions of burgy average 6s. 6d., the best qualities of slack are fetching 5s. to 5s. 6d., medium sorts 4s. to 4s. 3d., but common slack is obtainable at about 3s. 3d. to 3s. 6d. per ton.

With surplus quantities of common round coal pushed for sale, for shipment, very low prices are necessarily ruling at the ports on the Mersey, and ordinary descriptions of steam coal are not fetching more than 8s. 9d. to 9s. 3d. per ton, delivered at the Garston Docks, or the High Level, Liverpool.

The competition for gas coal contracts from outside districts, to which I have previously referred, is weakening the position of Lancashire colliery owners, and concessions of 3d. per ton upon last year's rates are very general; whilst under exceptional pressure there is in many instances a giving way of something like 6d. per ton to secure contracts. Most of the principal contracts have already been settled, but there are a number of them yet pending, and these are in many cases being held back, with a view of obtaining amended tenders, at lower prices.

Barrow.—There is a quiet business in hematite pig iron, but the demand is growing on all sides, and it is expected that makers will be able to secure some large contracts immediately after the close of the election. Orders for Bessemer qualities are more frequent than they were on steel account, and the trade from this quarter is expected to improve. Prices are steady at 49s. 6d. net cash for hematite warrants, but makers are asking 51s. for parcels

of Mixed Bessemer Nos. net f.o.b. The trade doing in forge and foundry iron is very small, and some stocks of this class of metal are held. Thirty-nine furnaces are in blast, and one or two others will be blowing in the course of a few days. Stocks have been futher reduced about 500 tons, and now stand at 44,560 tons. Makers hold next to no stock.

Iron ore is in quiet demand, but fuller deliveries are being made chiefly on old contracts. Ordinary qualities of iron ore are quoted at 9s. per ton net at mines.

Steel makers are busily employed in both the Bessemer and the Siemens-Martin departments, and orders are held which in all probability will maintain the present position for at least four months. Prices are steady, but are not very remunerative. In the steel shipbuilding material business there is a steady demand on local, Belfast, and general account. Plates are at £8 per ton. Steel rails are at £4 2s. 6d. to £4 4s. per ton for heavy sections.

Shipbuilders are busily employed on both new orders and repair work, and engineers have also plenty of work in hand for some time to come.

The coal and coke trades are steady. Coke is in full supply and in liberal demand, and 20s. per ton is now the price delivered from Durham ovens at West Coast furnaces.

In the shipping trade there is a marked depression, and the exports of pig iron and steel show a very considerable falling off on recent experiences. The trade in exports is, however, expected to improve, now that the furnaces are again in full blast.

A fair trade is being done in petroleum, and the tanks at Barrow are fairly filled with oil.

Some improvement has been noticeable lately in the timber trade, and some large shipments of Baltic and American timber have lately been imported.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

FIVE days a week in the coal trade are amply sufficient for the demand. In some quarters four days a week are being worked, and although stocks have not yet begun to accumulate after the clearance effected by the strike in the North, there is no doubt that the output is in excess of the demand. The inquiry for house coal is at present very quiet, and Durham now resuming its supplies, has caused, with the warm weather, a weaker tone to prevail in the London market, and lower quotations are ruling. Pit prices are about as follow:—Silkstones, 10s. to 12s. per ton; Barnsley house, 10s. to 10s. 6d. per ton; other qualities, 9s. per ton and upwards. The Humber ports are taking a full tonnage of steam coal, last year's demand being quite sustained, and prices running from 8s. 9d. to 9s. 6d. per ton. Manufacturing fuel is at 5s. to 6s. per ton; small coal and smudge in good request; gas coal rather more languid. In West Yorkshire, as in South Yorkshire, business is rather below the average, only about four days' work being required to meet the requirements.

Railway material is being largely inquired after, and it is hoped that another period of briskness is at hand. An average turn-over is reported in the heavy iron trades. Our military authorities are expected to order freely, in a short time, in shell and armour-piercing projectiles, as the result of inquiries now being made in the district. In steel a considerable amount of business is being done with the United States, chiefly of the best classes for cutlery, milling tools, &c. This is not quite a satisfactory feature of our business, as it simply means the buying of the raw material to make in America the cutlery and other wares which used to find employment for many hands here. Another market has been closed to this country through the new tariff which came into operation on the 30th ult. During the spring and summer months, large quantities of goods have been exported to Spain and Portugal by Sheffield manufacturers, to get them in before the tariff came into force. Trade with Spain and Portugal, it is feared, will now be paralysed for years in many departments of industry. Firms that have been at great trouble and expense to send out travellers and appoint agents in the Peninsula, have now their trouble for their pains.

The annual meeting of John Brown and Co., Atlas Steel and Iron Works, Sheffield, was very largely attended last Friday. Mr. J. D. Ellis, chairman of the company, presided. The chief interest of the chairman's speech centred in the account given of successful sinkings at the Rotherham Main Colliery. The High Hazel Seam, which had been won at a depth of 340 yards, instead of being 4ft. 6in. thick, was 6ft. thick, and of a very superior quality, almost as good as Cannel; the Barnsley seam was found 8ft. thick. Specimens of the coal were in the board-room. The chairman expressed regret at the death of Mr. J. C. Duncan, the secretary, and mentioned that Mr. J. E. Townsend, who had been with the company a great many years, had been appointed in his place—an announcement which was cordially endorsed by the shareholders. The dividend declared was 10 per cent. for the year.

The total exports of goods from the Sheffield Consular District to the United States during the quarter ending June 30th have been supplied to me through the courtesy of the Consul, Mr. Benjamin Folsom. Cutlery, for the three months, shows a value of £33,090, against £21,666 for the corresponding quarter of 1891. That, however, was the lowest point ever reached. In steel the States took a value of £66,896, which is £1500 less than a year ago. The total value of exports to the States during the quarter was £122,427, as compared with £112,108 in the second quarter of last year. Business, though thus slightly improved, is far below what it was before the McKinley Act narrowed the gate.

Mr. W. E. Lilley, of the Institute of Marine Engineers, and a number of gentlemen students belonging to the Dublin University School of Engineering, visited Sheffield on Friday. They were shown round several of the large establishments, including Messrs. Vickers, Sons, and Co., where they saw some of the most important heavy manufactures in the steel trade. They were particularly interested in the gigantic appliances used for the production of heavy forgings and the most highly-finished description of ordnance. At the Bessemer Works—Messrs. Henry Bessemer and Co.—they witnessed the production of both Bessemer and Siemens steel. The whole process was explained to them, and the visitors expressed the hope that some day, when the mineral resources of Ireland were developed, it would be their good fortune to obtain as good a position in Ireland and as much trade support as England had to-day for the manufacture of steel by both methods of production. The tire-rolling mill and the cogging and rolling mills were visited, and the different hammers and hydraulic presses were explained. The students expressed themselves much gratified with their visit.

The *Newcastle Chronicle*, in its trade report, has a note of special interest to Sheffield in connection with the visit to the Atlas Works of the members of the North East Coast Institute of Shipbuilders and Engineers on the 24th ult. Many of the visitors, it is said, were "struck with the large amount of work in execution for this district. Armour-plates for vessels building on the Tyne, furnaces for ship boilers, tubes for marine engines, crank-shafts, &c., all for use at the ports. The raw material is imported often, and then it goes from the ports, and the manufactured articles are used in our ship and engine-yards. These facts ought to suggest the possibility of our local trades being increased by work of the kind named being done at the ports. The iron could be smelted there, and all the processes gone through with a saving of carriage that would in itself be a profit of moment." There is a kind of Yankee ring about these sentiments. Our American cousins were wont to come over here, see everything, and go away charmed with the reception and hospitality they received—to start the same manufactories themselves as early as possible. But such establishments as the Atlas works are not built up in a day. They are the slow growth of years, the result of many brains, the survival of the fittest after costly trials and experiments.

A fortnight of electioneering has done no good to business. Locally the excitement is having less prejudicial effect than was anticipated, but the general influence is to disorganise business. There will be nothing done in the country districts until the nation has completed its verdict, and the new Parliament is elected. The lighter industries are feeling the depression more severely than the heavy trades; but those engaged in both will be thankful when all is over.

Mr. James Laycock, who has had fifty-three and-a-half years' continual work as a mechanical engineer in the service of one firm—Messrs. Vickers, Sons, and Company—has just retired into private life. For the last thirty years Mr. Laycock has managed the engineering department, under the superintendence of Mr. E. Reynolds. During the whole time Mr. Laycock has been connected with the River Don Works, he has won the general esteem of employers and employés alike. The manager, clerks, and foremen presented him with a tea-service; the men in his own department with a case of cutlery, and Mr. T. E. Vickers, J.P., chairman of the directors, a drawing-room timepiece in the name of the board and the firm.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

VARIOUS circumstances have this week tended to limit the transaction of business, the first and foremost being the general elections, and another almost as potent being the "squeeze" that has been in progress with respect to Middlesbrough warrants, but which now fortunately seems to be at an end, so that next week we may hope to see a resumption of business. The "squeeze" has been more prolonged than was expected, and has caused considerable disorganisation in the market, but the "bears" have only met with the treatment they deserved, and which it is hoped will teach them a lesson that they will not soon forget. They have been too bold this time in operating with Middlesbrough warrants, and have overreached themselves. It might have been thought that with their experience they would have recognised that it has not been recently a favourable time to "bear" the market, seeing that next to no iron was being made, that stocks were going down so rapidly both in makers' hands and the warrant stores, and that what stock of warrants was held was owned by a few hands who were agreed to operate together, and who practically had the warrant market in their own hands. The speculators, however, appeared to think that after the Durham strike was over prices would drop, and they therefore sold Middlesbrough warrants for delivery at fixed dates at the prices then current, but they delayed covering in the expectation that the value of iron would fall before the date of delivery, and so enable them to derive profit out of the transaction. However, the prices did not fall after the close of the strike, for holders having such small stocks were able to keep up their quotations, and there was nothing for it then for the "bears" but to purchase the iron at prices considerably higher than they had intended to give. But when they came to buy they found themselves "cornered," for they could not get the warrants neither could they procure makers' iron, which they might send into the public warrant stores, and thus extricate themselves from their difficulties. The result was that they were at the mercy of the "bulls," and being unable to deliver the warrants they had contracted to supply, they had to make the best terms possible with the buyers, and settle differences on a basis a good deal above what was paid for warrants before the "squeeze" set in. The warrants were due for delivery about the end of June and in the early days of July, and the time is now over, so that the "squeeze" may be said to have collapsed, and ordinary business will now be permitted to recommence. Fully 50s. was paid to buyers by "bears," who could not carry out their contracts, whereas makers' iron did not reach more than 42s. The "bears" would gladly have given this and put the iron into store, but, unfortunately for them, the iron could only be bought in very small lots, too small to allow of sending into the public stores.

The demand for pig iron by consumers is at present quiet; and is confined to prompt requirements, for the general opinion is that as the output increases the value of iron will become more in favour of the buyers. And this is evidently the view also taken by the sellers, for they are offering iron for forward delivery at less than they will accept for prompt. Thus 40s. 6d. has been the prompt price of No. 3 asked by merchants, but 40s. would be taken for next month's delivery, and 39s. 6d. for September delivery, but buyers were not willing to give as much for forward delivery, though they would pay 40s. 6d. for No. 3, for prompt, and offered 40s. rather readily, because No. 3 is very scarce yet, seeing that the furnaces have as yet made next to none, and that quality cannot be had from the public warrant stores, seeing that the holders thereof are agreed upon not selling at present. Makers have been quoting 41s. for prompt deliveries of No. 3, and 40s. for August and September deliveries. The prices named above for No. 3 are for small quantities only—parcels, say, under 100 tons—but for larger quantities more is offered, but the iron is unobtainable. Middlesbrough warrants ceased to be quoted at all in the early part of last week, and no figure was named for them until Tuesday this week, when sellers were at 43s. and buyers at 40s. cash; but this wide difference did not lead to any business, as the pressure to buy is over, the "squeeze" having collapsed. Wednesday's sellers' price was 42s. cash, and buyers 40s. The quantity taken out of the public warrant stores is now very small—it has been about 500 tons this week, whereas during the three months ending June 30th it averaged 8000 tons per week. It is not that the output of No. 3 has increased, for little has been made, but it is trade tapering off that has caused the quietness at the stores. It is remarkable that five-sixths of all the pig iron in the district is now in Connal's stores, and the total quantity there and in makers' hands does not exceed ten days' make, whereas the makers themselves only hold unsold a couple of days' production.

The prices of the lower qualities of pig iron are not so firm as are those of No. 3, because the supply is better, seeing that the furnaces that have resumed operations have chiefly made these lower qualities. Indeed, so much white has been produced that it has become practically a drug upon the market, and will not realise, as a rule, above 36s. 6d., whereas a short time ago 38s. 6d. was paid for it. Grey forge can be bought at from 38s. to 38s. 6d., which in June could not be had under 40s.; and No. 4 foundry is at 39s. Almost all the hematite furnaces are again at work, and producers are importing Spanish ore very freely. For mixed numbers they are quoting 50s. per ton, and Spanish Rubio ore is about 13s. per ton ex ship Tees. The quarterly iron market is to be held at Middlesbrough Royal Exchange next Tuesday, when free admission will be given to all connected with the iron, coal, and allied trades.

The June statistics of the Cleveland Ironmasters' Association have been awaited with no little interest, as they were expected to show how far operations had been resumed. It appears from them that seventy-one of the eighty furnaces which were stopped during the strike have recommenced work, and two others which were idle previous to the strike have been lighted, viz., one at Messrs. Gjers, Mills and Co.'s Ayresome Ironwork, and the one at Messrs. Bolckow, Vaughan and Co.'s Middlesborough Ironworks, both to produce hematite. Thus seventy-six furnaces are now in operation against eighty-three when the strike began. The production for June was 57,765 tons, as compared with 6124 tons in May, 213,045 in June, 1891, and 232,480 tons in June, 1890. Of Cleveland iron alone 16,694 tons were made against none in May, and 125,832 tons in June, 1891. The figures regarding stocks are most remarkable, showing a decrease of 39,491 tons, and leaving only 48,472 tons in stock. Such a small stock has never been known since the Cleveland iron trade attained to important dimensions. A year ago 268,282 tons were held, and four years ago above 650,000. The figures with respect to make and stock are as under:—

Make of Pig Iron.

	1892. June.	1892. May.	Increase.	Decrease.
	Tons.	Tons.	Tons.	Tons.
Cleveland pig iron—port of Middlesbrough	15,017	—	15,017	—
Ditto—outside Middlesbrough	1,947	—	1,947	—
Ditto—North of England district	16,964	—	16,964	—
Other kinds of pig (including hematite, spiegel, and basic pig iron)—whole district	40,801	6124	34,677	—
Total of all kinds—whole district	57,765	6124	51,641	—
Number of furnaces on Cleveland pig iron on June 30th	38	—	38	—
Number of furnaces on hematite, &c., on June 30th	38	3	35	—
Total	76	3	73	—

Stocks of Cleveland Pig Iron.

	1892. June 30	1892. May 31.	Increase.	Decrease.
	Tons.	Tons.	Tons.	Tons.
Makers' stocks—port of Middlesbrough	6,976	20,242	—	13,266
Ditto—outside ditto	542	3,517	—	2,975
Ditto—North of England district	7,518	23,759	—	16,241
Makers' stores—ditto	650	650	—	—
Pig iron in public stores:—				
The N.E. Railway Co.'s	295	295	—	—
Connal's	40,009	63,259	—	23,250
Total	48,472	87,963	—	39,491

With respect to pig iron shipments from Middlesbrough, which, exports nearly all the pig iron made in the North of England, the quantity in June only reached 31,694 tons, that being the smallest reported in any month since records were kept, and never since January, 1879, have the exports ever fallen below even 40,000 tons. The small shipments were due to the fact that there was so little iron made—almost no No. 3, which is the quality required for shipment—and Middlesbrough warrants, which are No. 3 iron, could not be got. The prices of Cleveland iron were relatively so much above those of other districts that consumers were induced to obtain supplies elsewhere. The following is a comparison of the June exports, and those of the months named:—

	Coastwise. Tons.	Foreign. Tons.	Total. Tons.
June, 1892	8,534	23,160	31,694
May, 1892	17,706	38,486	56,192
June, 1891	43,375	34,669	78,044
June, 1890	23,396	58,762	82,158

To Scotland, which in June, 1891, took 38,090 tons of Cleveland pig iron, but 5090 tons were sent, but Cleveland iron was 5s. or 6s. per ton dearer than Scotch to the Scotch consumer. To Germany 10,585 tons were sent, against 15,435 tons in June, 1891, and 34,213 tons in June, 1890. During the half-year Middlesbrough pig iron shipments only reached 295,618 tons, against 421,122 tons in 1891, 381,939 tons in 1890, and 489,870 tons in 1889.

Business in finished iron and steel is dull, and orders are confined to those for prompt delivery, as no one will buy for forward delivery in the present uncertain and discouraging state of trade. All the works which were stopped during the Durham strike have now resumed operations, the North-Eastern Steel Company, Middlesbrough, the last of these, re-starting a few days ago. Prices are well maintained: Common iron bars at £5 10s.; best bars at £6; iron ship-plates at £5 5s.; steel ship-plates at £5 17s. 6d.; iron boiler-plates at £6 5s.; iron ship angles at £5 2s. 6d.; and steel ship angles at £5 12s. 6d.; all less 2½ and f.o.t. at producer's works. Heavy steel rails are £4 net at works.

Among the local members who have been so far elected for the new Parliament are Mr. Theodore Fry, iron manufacturer, Risecarr Rolling Mills, Darlington, for Darlington; Mr. Thomas Wrightson, engineer and ironfounder, Teesdale Ironworks, Stockton, for Stockton; and Mr. Christopher Furness, shipbuilder, West Hartlepool, for the Hartlepools.

Some forty-seven of the members of the Société des Ingenieurs sortis de l'Ecole Provinciale d'Industries et des Mines du Hainaut, have been visiting the mining districts of Northumberland and Durham, under the auspices of the North of England Institute of Mining Engineers. They visited Ashington Colliery, Newbottle Collieries, the pier and the river works of the River Wear Commission, the Salt Works on Teesside, Lumpsey Ironstone Mines, &c.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

TOWARDS the close of last week a "corner" took place in Cleveland warrants in the Glasgow pig iron market. Warrants were so scarce that the price rose from about 41s. to 50s., and the latter price was paid for a large quantity of iron up till Monday's settlement. Accounts were then squared, at least for the time, and price fell back to 40s. A moderate business has been done in Scotch warrants between 41s. and 41s. 6d. cash, but there has been scarcely any inquiry for hematite.

The prices of pig iron are as follows:—G.M.B., f.o.b. at Glasgow, Nos. 1 and 3, 42s. per ton; Monkland, No. 1, 43s. 6d.; No. 3, 42s. 6d.; Carnbroe, No. 1, 44s.; No. 3, 43s.; Clyde, No. 1, 47s. 6d.; No. 3, 47s.; Gartsherrie, Langloan, and Calder, Nos. 1, 49s. 6d.; Nos. 3, 47s. 6d.; Summerlee, No. 1, 50s.; No. 3, 47s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 48s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s.; No. 3, 47s. 6d.; Dalmellington, No. 1, 47s. 6d.; No. 3, 46s. 6d.; Eglinton, No. 1, 46s. 6d.; No. 3, 45s. 6d.; Shotts, at Leith, No. 1, 52s.; No. 3, 50s.; Carron, at Grangemouth, No. 1, 54s.; No. 3, 47s. 6d.

The past week's shipments of pig iron have been 4872 tons, against 4364 in the corresponding week. Canada took 400 tons, Australia 300, France 455, Italy 618, Germany 810, Holland 240, Russia 120, India 85, Belgium 10, other countries 90, the coastwise shipments being 1744 tons, against 2039 same week last year. The total shipments for the six months are 158,525, compared with 124,923 in the first half of 1891.

Since last report, the number of furnaces producing ordinary and special brands has been increased from 37 to 39, and there are still 31 making hematite and 6 basic, the total in operation being 76, compared with 74 in the previous week and 72 in the corresponding week of last year.

There is comparatively little doing in the ore import trade as far as regards the arrangement of new business, but smelters have ample supplies. The rates of freight from Bilbao to Glasgow have a slightly easier tendency, and the prices of ore delivered are for campanil 13s. 9d. to 14s., and rubio 11s. 9d. to 12s. 3d. per ton.

The pipe founding trade presents a rather more hopeful prospect. Our founders are taking a lively interest in forthcoming contracts for water-pipes for Birmingham, Newcastle, Bradford, Lurgan, &c., and this week the Corporation of Glasgow has come into the market for upwards of 10,000 tons of pipes to be used in the extension of the Loch Katrine Waterworks.

There is little change in the position of the steel trade. A few new orders have been coming in for shipbuilding material, and

work is proceeding quietly, but the outlook for the future is not very encouraging. At present it is difficult to see from what sources business is to spring in sufficient quantity to keep the works going after the holidays, which begin at the end of next week, and will practically extend to about the close of the month. Prices of steel are still on the basis of £6 3s. 9d. to £6 5s. for ship-plates, less 5 per cent. for delivery in Glasgow district.

In the malleable iron department business is for the most part very quiet, with hardly any new feature of interest to notice. Makers are dragging along as best they may, booking a small order now and again and hoping for better times. They quote angle iron at £5 12s. 6d.; the lowest grade of common bars, £5 15s.; second grade, £6; highest grade, £6 2s. 6d.; best bars, £6 5s. to £6 12s. 6d.; nail rods, £6; sheets, £7 7s. 6d.; all the rates being subject to the usual 5 per cent. discount.

The iron and steel manufactured goods shipped from Glasgow in the past week embraced machinery to the value of £41,845, of which £31,241 represented sewing machines, steel goods £4900, and miscellaneous iron goods £26,346.

The coal trade continues fairly steady, notwithstanding that the amount of export business being arranged is comparatively small. The coalmasters and shippers are well occupied with existing orders, which they will have to clear off within the next few days, and they are looking forward to a better demand about the beginning of August. Main coal is quoted, f.o.b. Glasgow, 7s. 6d.; splint, 8s. to 8s. 3d.; ell, 8s. 3d. to 8s. 6d.; and steam, 10s. to 10s. 3d.

During the six months ending 30th June there has been launched from the Clyde shipyards 164 vessels, with an aggregate tonnage of 185,805, compared with 170 vessels, and 174,280 tons in the first half of last year. The output has only been previously exceeded in the first half of 1883, when 195,702 tons were put into the water. While the amount of work turned out since the beginning of the year is thus comparatively large, the orders in hand are materially less than they were twelve months ago, and it is feared that a period of slackness is gradually coming over the trade.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE elections have seriously interfered with all business during the week, and the subject of coal seems to have sunk completely before the more absorbing topic of politics. This has been the case amongst the offices, at the Exchange, collieries, and steel works, and it is fortunate that the political fever only lasts a week. As soon as local elections are finished the excitement will abate, and it is very likely an extra spurt will be made in all departments to make up for the loss.

In coal there is the same seeming anomaly, a decline in price, and great shipments. The latter I have accounted for as due to the large contracts made which have insured, and will for some time, a continuance of large exports of coal. The declining price on 'Change shows what we have to expect. Midweek, at Cardiff, best steam was quoted at 11s. 9d. to 12s.; seconds realised about 11s. 3d.; some coals at 10s., and small from 5s. 6d. Even in house coals things seem to be on the declining plane, and 12s. to 12s. 3d. appears to be about the fixtures. Brush coal 10s. No large from 8s., and small best 8s. 3d.

Coke continues tolerably firm, furnace 18s. to 18s. 6d., and foundry 21s. 6d. to 22s. 6d. at Cardiff. Swansea prices are: Furnace, 15s. to 16s., and 18s. to 20s. for foundry. Patent fuel both at Cardiff and Swansea is quoted at 10s. 9d. to 11s. In Cardiff there are complaints of slackness in this commodity, but in Swansea there is more briskness. Last week the export from that port was 12,488 tons. Some of the largest shipments were as follows:—France, 2645 tons; Spain, 2850; Egypt, 2707; Italy, 1300; Russia, 1650; Algeria, 1270.

I have referred to the coal shipments as having been large. Last week, ending Wednesday, the shipments from the Cardiff ports came nearly to 300,000. The exact total of the Bute Docks was 172,809. For the week ending Saturday, Barry sent 89,702 tons, and Penarth 39,628 tons. Swansea's total was close upon 34,000, and Newport maintained a fair average. Newport's future is becoming more assured. What with the prospects of the extended coalfields of the Rhymney and Ebbw Vale Companies, and the prospects of other leading companies, such as the Newport Abercarn, which has announced a 10 per cent. dividend on the year, the outlook is promising. Last year the output of this colliery was 458,000 tons, and by the opening out of the Black Vein—lower—still larger is certain.

This week there was an interesting ceremony at Newport, in the form of opening an important dock extension, adding twenty-eight acres to the Alexandra Dock area. At present the new space will be used for the largest vessels that come to Newport, and will be of marked service. Hoists and all necessary appliances are to be added. There was a distinguished party at the ceremony, including Lord Tredegar, Sir George Elliot, Sir Geo. Walker, Mr. Parkinson, Col. Lyne, Mr. Lawrance, Mr. Phillips, and the indefatigable dock master Mr. Parfitt. Mr. Smythe and Mr. Layborne, engineers, took an active part in the proceedings by opening the sluices, &c.

There is not much to record this week in connection with the steel works, which have enjoyed a better trade of late. Large orders for rails and steel bars are in hand covering some time to come, and, as will be seen, quotations are slightly better.

Pig iron has fluctuated somewhat during the week. Prices midweek were as follows:—Glasgow pig, 41s. 2½d.; Middlesbrough, No. 3, 40s., hematite from 49s.

Other productions were quoted as follows on Swansea 'Change:—Steel rails, heavy sections, £4 2s. 6d. to £4 5s.; light, £5 5s. to £5 10s.; sheet iron, £6 10s. to £7 10s.; steel, £7 10s. to £8 10s.; Welsh bars, £5 5s. to £5 7s. 6d.; Bessemer steel blooms, £4 7s. 6d. to £4 10s.; tin plate bars, £4 12s. 6d. to £4 15s.; Siemens, £5 to £5 2s. 6d.

Foreign ore continues to arrive in large bulk. Prices remain bad —10s. 9d. to 11s.

Good business continues in tin plates. It was rumoured in Swansea this week that Sir John Jones Jenkins has offered to buy and re-start the Old Lodge Works, Llanelly. These, on account of slack times, have been closed for a period. Exports continue large. Last week the shipments of tin-plates from Swansea amounted to 67,697 boxes; received from works, 80,668 boxes. Present stock is now comprised of 157,510 boxes, which is little enough considering that one week's good rush would clear it.

Business is a little quieter on account, it was stated on 'Change, of the general tendency of tin-plate makers to hold out for better prices. Quotations this week are:—Bessemers, 12s. 3d. to 12s. 6d.; Siemens, 12s. 6d. to 12s. 9d.; ternes, 22s. to 24s. and 26s.; best charcoal, 13s. 6d. to 13s. 9d. Block tin is at £99 2s. 6d. to £100.

The directors of the Rhymney Iron Company have issued their report. They had hoped to have declared another dividend of 1 per cent., but the unfavourable aspect of the coal trade and the necessity for further outlay for the completion and development of the company's new pits prevent this. No steel has been manufactured since March; but there has been increased development of the coalfield, and in that direction prospects appear favourable, especially if prices again go upwards.

I note that Messrs. W. Perch and Co., of Cardiff, have won coal at their new pit Abergwynfi. The section struck is good, and the company will continue sinking to the deep.

There is considerable difference, I find, between the earnings of steam coal and anthracite men. At one of the Cyfarthfa collieries a good collier can still earn his £3, and even £3 10s. a week, whereas at Saundersfoot—anthracite—in Pembrokeshire, the average is not above 25s. The Castle pit, Cyfarthfa, continues to yield excellent coal. The 9ft. there for some time has proved almost equal to the best 4ft. This pit is being worked with great energy and ability. Two trams of coal ascend every half minute in a working day of twelve hours, depth 250 yards, which will give an idea of the speed.

It was reported on 'Change, Cardiff, Tuesday, that several Cardiff coal merchants have been badly hit by the failure of an Indian firm. Losses are estimated at £50,000 to £60,000

The Taff Vale Railway keeps to its vigorous development. With July, additional trains have been put on, which serve the district well, and blend in capitally with the Cambrian Railways, which are now entering upon their perigee. The Taff shares are going up, and are in good demand. Last week showed an increase in revenue of £104.

NOTES FROM GERMANY.

(From our own Correspondent.)

CHANGES of an important character have not been observed in the general iron trade this week, the steady, somewhat cautious course prevailing in every direction pointing, however, steadily to gradual improvement. Altogether, the actual present condition, as well as the outlook to the near future, are decidedly more cheering than they have been for many months past.

In Silesia the condition of the iron market cannot be termed very satisfactory just at present. In pig iron, as well as in manufactured iron, the demand coming forward is only moderate. The hopes which were generally entertained by the works some time ago have not been realised. There is no doubt that the Rhenish-Westphalian works have strongly shaken the prices of the Silesian works, so that the latter are hardly able to maintain their position. At a late tendering at Breslau, rails were offered at M. 120 to M. 122 p.t., sleepers at M. 126 p.t.

In Austria-Hungary prices on the pig iron market have been very firmly maintained upon the week. In almost all branches of the malleable iron trade likewise a fair business is doing. Bars especially are in good call, and meet with ready sale at firm quotations. For heavy plates a moderate inquiry is being experienced, while sheets complain of rather weak request.

The situation of the French iron market has only very slightly changed during the last few weeks. In the northern districts the orders coming in, though less in number than they were two months ago, are yet sufficient to secure fairly regular employment to the works. Prices may be reported as pretty firm, on the whole. For bars No. 2 145f. to 150f. has been fixed as basis price; girders No. 2 are quoted 155f. p.t. For heavy plates 170f. to 180f. p.t. has been asked; boiler plates No. 3 are quoted 205f.; steel plates 200f. p.t.; old rails are sold at 80f. p.t.

In the Group du Centre the iron business is in a less favourable state, inquiry being rather weak. Employment has, nevertheless, been fairly well maintained at most of the works on orders previously booked. In the Eastern group, the Comptoir de Longwy is doing a fair amount of business. Prices are reported as very firm on the whole. White forge pig is quoted 55·50f. p.t.; grey do, 58f.; foundry, No. 1, 63·50f.; No. 3, 66·50f.; No. 4, 65·50f.; No. 5, 64·50f. p.t. In Paris bars are sold at 165f., girders 175f. p.t. In consideration of the favourable building season it is astonishing that for the latter article concessions continue to be made.

The Belgian iron market is again exceedingly quiet. Consumers intend to go in against the syndicate prices, which are, on the whole, regarded as unwarranted. For the present quotations have remained unchanged: Luxemburg foundry, No. 5, 48f.; forge pig, 44f. p.t. Bars, No. 1 for Inland, 120f.; sheets, 170f.; plates, No. 3, 140f. p.t. The export of iron and steel has decidedly increased against previous year. In steel rails 5500 tons more were exported; in iron rails 500 t. more; in steel manufactured goods 8500 t. more. In plates 4000 t. more were exported than in previous year, whereas in bars 6000 t. less were exported.

The reports coming in regarding the Rhenish-Westphalian iron market are of a somewhat more cheering character. Prices are firm, in some cases even increasing, though only slightly for the present. Also with regard to employment an improvement may be noticed in almost all branches. The iron ore trade is pretty satisfactory. Demand has increased, and this has led to a slight raising of prices; spathose iron ore being now noted M. 8 to 8·40 p.t.; roasted ditto, M. 11 to 12 p.t.; inferior sorts, M. 10·50 to 11 p.t. net at mines. Nassau red iron ore is paid with M. 9 to 9·20 p.t.; free Dillenburg. Luxemburg-Lorraine minette has somewhat stiffened in price, M. 3·20 being paid for the 40 p.c. contents, minor qualities being noted M. 2·40 to 2·60 p.t. at mines. A regular demand is being experienced in the pig iron branch. As production is about equal to consumption, stocks are likely to remain in their present condition. Spiegeleisen has been quoted M. 55 p.t. Rhenish-Westphalian forge pig No. 1 is quoted M. 50; No. 3, M. 45 p.t. Siegerland good forge quality is quoted M. 48; hematite, M. 66 p.t. Foundry No. 1, M. 65 p.t.; No. 3, M. 57. Basic, M. 47·50 to 48 p.t. at works. Bessemer stands at M. 54 to 55 p.t.; Luxemburg forge, M. 40 to 40·50 p.t. at works. There is a pretty lively tone perceptible in the finished iron department. Bars are well inquired for, on the whole; in some quarters, however, an absence of large orders is keenly felt. Girders continue to meet with ready sale, prices remaining, unfortunately, as low as before. Under the circumstances, the proposed agreement between the works themselves would be most opportune, because though foreign competition would still have to be met, there would at least be no longer any fighting among themselves, and so prices might begin to revive. The hoop trade remains unchanged, animated request and firm quotations being the order of the day. There is an active inquiry coming forward for plates, in many instances production being scarcely able to cover consumptive demand.

The wire mills report themselves vigorously engaged, prices remaining firm. The irregular employment of the ironfoundries and machine factories continues to be complained of, while the wagon factories have, until now, been pretty satisfactorily occupied.

Latest list quotations, per ton at works, are as follows:—Good merchant bars, M. 115 to 120; angles, M. 125 to 130; girders, M. 85 to 87, in some cases, M. 90; hoops, M. 130 to 135; billets in basic and Bessemer, M. 85 for large lots; heavy boiler-plates, M. 160; tank ditto, M. 150; steel-plates, M. 150; tank ditto, M. 140; sheets, M. 135 to 150; Siegen thin sheets, M. 130 to 135; iron wire rods, common quality, M. 120 to 125; rivets, M. 155 to 160; steel rails, M. 112 to 120; fish-plates, M. 117 to 135; steel sleepers, M. 112 to 118; complete sets of wheels and axles, M. 275 to 285; axles, M. 220; steel tires, M. 210 to 230; light section rails, M. 95.

The production of pig iron in Germany and in Luxemburg during the last twenty years is shown by the following figures:—

Year.	Number of furnaces.	Men employed.	Quantity in 1000 t.	Value in M. 1000.	Value p.t.
1872	348	26,111	1988	222,342	111·82
1873	379	28,129	2241	248,615	110 96
1874	339	24,342	1906	161,122	84·52
1875	289	22,760	2029	146,175	72·03
1876	236	18,556	1846	114,841	62·20
1877	212	18,188	1933	111,655	57·77
1878	212	16,202	2148	114,582	50·75
1879	210	17,386	2227	112,852	50·46
1880	246	21,117	2729	163,390	59·87
1881	251	24,387	2914	163,975	56·27
1882	261	23,015	3381	195,708	57·89
1883	253	23,515	3470	184,984	53·31
1884	252	23,114	3601	172,640	47·95
1885	229	22,768	3687	160,947	43·65
1886	215	21,470	3529	142,266	40·32
1887	212	21,432	4024	166,443	41·36
1888	211	23,046	4357	191,820	44·11
1889	213	23,985	4525	217,371	48·04
1890	222	24,846	4685	267,880	57·44
1891	216	24,468	4525	227,360	50·25

The favourable height of the water, and the general activity in many branches of industry requiring coal, coke, iron, minerals, wood, and other heavy or bulky goods, besides the frequency of passenger traffic at this season, have all united in bringing about an unusually lively river navigation, especially on the Rhine. Thus it was observed a short time ago that no less than 129 vessels —including three big rafts—had passed the bridge at Coblenz in one day. It is now proposed to establish a new line of direct communication between the industrial centres of the Lower Rhine and the southern parts of Germany, which, while avoiding the delay and the expenses of intermediate agencies at the various harbours and stations, will offer many advantages and facilities to the commercial world. The line will be Ruhrort-Strassburg. Great hopes are entertained in the industrial and commercial centres on both sides with regard to the probable success of this undertaking, which is destined to establish direct communication between London and Strassburg.

In the Rhenish Westphalian mining districts—more especially in the immediate neighbourhood of Dortmund—the commemoration of the centenary of the Royal Chief Mining-office, has given rise to many and very cordial meetings between officials and mine-owners on the one hand, and masters and men on the other. A retrospect to June 26th, 1792, could not but speak in very strong language to every one of them of the great things that have since been done for them, of the marvellous progress they have been enabled to make, and also of the prospects which are opening in spite of existing difficulties. This is in the first instance relating to coal, but iron is too closely connected with coal to allow of any separation. Official dates give the following particulars:—

	Production.	Value. M.	Sale. T.	Value of Sale. M.	No. of mines.	No. of miners.
1792 ..	176,676 ..	683,667 ..	151,127 ..	583,527 ..	154 ..	1,857
1800 ..	230,558 ..	1,039,015 ..	204,584 ..	921,630 ..	158 ..	1,546
1810 ..	368,679 ..	1,738,432 ..	333,950 ..	1,572,701 ..	177 ..	3,117
1820 ..	425,369 ..	2,279,140 ..	392,157 ..	2,102,047 ..	161 ..	3,356
1830 ..	571,434 ..	3,367,558 ..	549,390 ..	3,145,404 ..	172 ..	4,457
1840 ..	990,352 ..	6,396,380 ..	956 978 ..	6,006,310 ..	221 ..	8,945
1850 ..	1,665,662 ..	10,385,094 ..	1,683 692 ..	9,995,004 ..	198 ..	12,741
1860 ..	4,365,534 ..	28,005,022 ..	4,038,369 ..	25,990,158 ..	281 ..	29,320
1870 ..	11,812,528 ..	67,626,048 ..	10,957,358 ..	62,731,912 ..	220 ..	51,391
1880 ..	22,495,204 ..	102,953,856 ..	21,179,972 ..	96,981,971 ..	202 ..	80,152
1891 ..	37,402,494 ..	312,779,932 ..	35,466,949 ..	296,593,957 ..	175 ..	138,729

LAUNCHES AND TRIAL TRIPS.

There was launched from Messrs. Earle's shipyard on Wednesday, the 6th instant, the finely-modelled iron screw steam yacht Queen for the corporation of the Trinity House, Hull, the principal dimensions of which are: Length, 125ft.; breadth, 22ft.; depth moulded, 11ft. 4in. She is schooner rigged, with pole masts fitted with derricks for lifting buoys; has a straight stem and elliptical stern, and is built to Lloyd's 100A yacht class. A handsome saloon and five state rooms are provided for the accommodation of the Chairman and Committee of Trinity House, the entrance to which is from a teak deck house. The saloon entrance, state rooms, and saloon are fitted up in elaborate style, and she will undoubtedly be an improvement on the old yacht which she has been constructed to replace. The machinery, also made by the builders, consists of a set of triple compound engines of excellent finish and neat design, with cylinders 12in., 20in., and 32in. diameter by 22in. stroke, and a steel boiler of ample size to work at 150 lb. steam pressure.

The paddle steamer, Elvira, built by Messrs. Blackwood and Gordon, Port Glasgow, for the Algeciras—Gibraltar—Railway Company, made her official trial on Friday last, having on board the chairman of the company, Mr. S. W. Todd; the superintendent, Mr. Trewent; the builders, and a small company of ladies and gentlemen. The dimensions of the steamer are:—Length, over all, 122ft.; breadth, 18ft. 6in.; depth 8ft. 1in. The engines are of the diagonal, two-cylinder, compound surface-condensing type; diameter of cylinders 20in. and 34in. by 36in. stroke, supplied by steam from a multitubular boiler having a working pressure of 110 lb., the draught being assisted by a fan supplying air on the undergrate principle. On the measured mile a speed of about 12 knots was obtained, the steamer being subsequently run at full speed for a lengthened period. She is intended for service in the Mediterranean, and is in every respect beautifully finished; her saloon, though small, being handsomely decorated in white and gold, and well lighted and ventilated. She has a steam windlass for working the anchors; a promenade deck covering the saloon and the machinery, and a second-class saloon forward below the main deck. At the trial the chairman of the company expressed himself as very much pleased with the vessel in every particular. After being boarded up for the voyage she will at once proceed to her destination.

ANTIFOULING PAINTS IN THE NAVY.—Last autumn we directed attention to the antifouling paint trials then being conducted in the Navy upon H.M.S. Orontes at Portsmouth, and in which the French composition introduced by our Naval Attaché at Paris figured so favourably. We further recorded, that in consequence of its satisfactory achievements in these competitions it was at once applied to the hulls of the first-class ironclads Howe and Camperdown. The latter vessel was docked at Portsmouth on Tuesday last, after a ten months' cruise as flagship of the Channel Fleet, and when her bottom was seen to be of an exceptionally clean and satisfactory character. This composition will be at once re-applied to this vessel. The French paint has also been applied to vessels of the White Star, Red Star, Inman, and British Indian Steamship companies, &c.

THE WATER SUPPLY OF CROMER.—The Cromer Waterworks Company, in view of the growing popularity of the town, have been engaged during the past two years in sinking a second well capable of giving a supply considerably in excess of that hitherto available. These wells are situated more than half a mile outside of the town. Owing to the sandy character of the upper strata great difficulty was experienced in sinking the new well, which varies from 8ft. to 5ft. in diameter, and has been carried to a depth of 138ft. from the surface. The chalk was reached at a depth of 138ft. below the surface, and with the object of insuring the purity of the supply by excluding all percolations from the strata above, the well has been lined to a depth of 151ft. with brickwork and iron cylinders. The new bore-hole, which is 20in. in diameter, extends from the bottom of the well for a further depth of 40ft. Two headings, each 6ft. by 4ft., have been driven for a distance of 100ft., one serving as a connecting link between the new well and the old borehole by means of which the town has hitherto been supplied. The permanent water level in the new well and old borehole is 110ft. from the surface, and, as already stated, all the water flows direct from the chalk. The well, with the headings, possesses a storage capacity of about 25,000 gallons, and the total yield, when the works are in full operation, will be at least 200,000 gallons per day, a supply that will suffice for the requirements of the town for many years to come, even at the present rate of progress. A new set of pumps and engine has been erected designed to lift 12,000 gallons per hour, and the entire system is now in duplicate so that in the event of a breakdown—an eventuality by no means likely to happen—a failure in the supply will, practically speaking, be an absolute impossibility. The water has recently been examined by Professor Frankland, F.R.S., the well-known water analyst, and he reports on samples taken from each well as follows:—"The two samples are of most excellent quality for dietetic purposes. They are absolutely free from all evidence of previous sewage or animal contamination, whilst for chalk water they are of very moderate hardness. Cromer may be congratulated on being supplied with one of the best waters in Great Britain." The works have been carried out under the direction of Mr. J. C. Mellins, M. Inst. C.E., of London, by Messrs. Tilley and Sons, of Walbrook, London. The pumps and machinery being supplied by Messrs. Robert Warner and Sons, of Walton-on-the-Naze, while the buildings at the surface have been erected by Mr. John Newman, of Cromer.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 30th.

THE continued absorption of gold by foreign countries is causing an unsettled feeling in banking and commercial circles on this side. A large volume of business is being done in the States, the figures for the week showing an excess over same week last year of 12 per cent. Next week's disbursements for dividends will exceed 100 million dollars. The iron trade continues weak and dull. Pig iron has been reduced, and finished products are likely to follow. Steel rail makers met and renewed former agreements. The threatened strike among the ironmakers will probably be amicably adjusted, though some mills will not resume unless the workmen sign a lower scale. Steel boiler-plate shapes and heavy sheet iron orders are coming in freely. Western iron centres are more active than Eastern. Large blocks of Southern foundry and forge iron are being offered at Ohio River points, but brokers hold back. The coal trade is active at all points.

NEW COMPANIES.

THE following companies have just been registered:—

Meiter Syndicate, Limited.

This company was registered with a capital of £15,000 in £10 shares, to carry into effect an agreement made 15th June, between C. W. Meiter of the one part and C. E. Gudgeon, on behalf on this company, of the other part, and to carry on business as manufacturers of and dealers in caoutchouc, gum, gutta-percha, &c.

The number of directors shall not be less than three nor more than five, the first are to be elected by the signatories to the memorandum of association; qualification 25 shares; remuneration not specified.

Automatic Gas Meter Company, Limited.

This company was registered with a capital of £50,000 in £5 shares to acquire certain patents relating to automatic gas meters, by which gas can be obtained by prepayment of a small commission, said patents being granted to Messrs. Thorp, Marsh, and Haynes; and with a view to the acquisition thereof, to adopt and carry into effect an agreement made May 25th between J. Haynes of the one part, T. G. Marsh of the second part, and J. Duff, on behalf of this company, of the other part. The first subscribers are:—

	Shares.
T. G. Marsh, 4, Corporation-street, Manchester ..	1
J. Greenall, 10, Ash-grove, Victoria Park, Manchester	1
J. Haynes, 126a, Duke-street, Liverpool	1
J. Duff, Barum House, Halifax, Yorks	1
F. Fleming, Savile-place, Halifax, Yorks	1
J. R. Atkinson, Spring Bank, Sowerby Bridge ..	1
W. Battle, 49½, Briggate, Leeds, Yorks	1

The number of directors is not to be less than three nor more than seven, the first being F. Fleming, W. Battle, J. R. Atkinson, J. Greenall, and J. Haynes. Qualification, 50 shares.

Automatic Bottle Cleansing Syndicate, Limited.

This company was registered with a capital of £20,000, in £1 shares, to acquire certain patent rights and inventions, in accordance with an agreement made 17th June, between W. and W. A. Clark of the one part, and J. W. Lance, on behalf of this company, of the other part, and generally to carry on business as iron founders, mechanical engineers, &c. The number of directors shall not be less than three nor more than five. The first are to be elected by the signatories to the memorandum of association. Qualification, £100. Remuneration, £50 each per annum and 5 per cent. of the net profits remaining after payment of 20 per cent. dividend.

Pacific and European Telegraph Company, Limited.

This company was registered with a capital of £100,000, in £10 shares, to adopt and carry into effect an agreement expressed to be made between the Brazilian Submarine, Western and Brazilian, the West Coast of America, and the Pacific and European Telegraph Companies of the one part, and Sir John Pender, K.C.M.G., of the other part, for the construction and maintenance of telegraphic communication between Buenos Ayres, Valparaiso, and Santiago. The first subscribers are:—

	Shares.
Sir J. Pender, K.C.M.G., 18, Arlington-st., S.W.	1
Sir J. Anderson, 62, Queen's-gate, S.W.	1
T. Fuller, 13, Chesterfield-street, W.	1
A. Wood, Abbey Wood, Belvedere, Kent	1
Lord R. H. Brown, Reigate, Surrey	1
R. Collett, 50, Old Broad-street, E.C.	1
R. M. Cunningham, 19, Great Winchester-street, E.C.	1

The number of directors is not to be less than three nor more than five, and each of the abovementioned first three companies is entitled to nominate one director for each 2300 shares of the original capital of the company held by them respectively. Qualification, £100. Remuneration to be fixed by the company in general meeting.

T. B. Wood and Son, Limited.

This company was registered with a capital of £30,000, in £10 shares, to acquire the undertaking of cotton spinners, &c., hitherto carried on by T. B. Wood and Son, at Middleton, Lancs. in accordance with an agreement expressed to be made between J. Wood of the first part, T. B. Wood of the second part, and this company of the third part, and to develope and extend the said business.

The number of directors shall not be less than three nor more than seven. The first are: T. B. Wood, W. H. Wood, and E. Wood. Qualification, 50 shares. Remuneration, £1 1s. for each board attendance.

Holloway Electricity Supply Company, Limited.

This company was registered with a capital of £2000, in £10 shares, to carry on the business of an electric lighting company in all its branches.

The number of directors shall not be less than three nor more than seven. Qualification, £500. Remuneration to be determined by the company in general meeting.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

21st June, 1892.

11,618. CORNISH BOILERS, R. Müller, London.
11,619. DRAWING INSTRUMENTS, M. Stühler, London.
11,620. PEN, R. Kinkead, London.
11,621. HORTICULTURAL IMPLEMENT, J. P. Britton, London.
11,622. GEAR for VELOCIPEDES, R. J. Crowley and J. R. Grant, London.
11,623. BOOT and SHOE SEWING MACHINE, D. Mills, London.
11,624. COIN-OPERATED TELEPHONE, H. H. Lake.—(*E. Noreiga, Mexico.*)
11,625. FAUCETS, H. H. Lake.—(*S. Schlanger, United States.*)
11,626. WHEELS for BICYCLES, &c, W. I. Bunker, London.
11,627. WHEEL TIRES, W. I. Bunker, London.
11,628. TOILET PAPER CASES, I. M. Lowengrund, London.
11,629. MAKING of FIGURED FABRICS, D. S. Williams, London.
11,630. STEAM ENGINES, H. H. Lake.—(*J. N. Gamble, United States.*)
11,631. STEAM ENGINES, H. H. Lake.—(*J. N. Gamble, United States*)
11,632. BICYCLES, J. Bradley and H. W. Bullock, London.
11,633. CLAMPING DEVICE, J. A. Findlay, London.
11,634. ELECTRIC RAILWAYS, F. Wynne, London.
11,635. HYDROCARBON ENGINES, &c., D. Young.—(*C. J. Berliss, Belgium.*)
11,636. STAMPING BREAD, &c., H. Barlow and A. Dawes, London.
11,637. HARMONICAS, C. F. Stahlecker.—(*A. B. Breinl, Austria.*)
11,638. TREATING SPIRIT, R. C. Scott, London.
11,639. PIPE CLEANERS, A. W. Montgomery-Moore, London.
11,640. ELECTRIC METERS, F. H. and H. Nalder, C. W. S. Crawley, and A. Soames, London.
11,641. SIGNS, R. O. Hearson and A. E. Bachrach, London.
11,642. FOOT WARMERS, C. Perman, London.
11,643. VENTILATOR, &c., E. J. Pool and A. O'Conor, London.
11,644. PORTABLE WEIGHTS and CASE, W. F. Grafton, London.
11,645. LIFE BELTS, F. W. Böhme and H. Hoffstümer, London.
11,646. SAD IRONS, A. Ashmore, Birmingham.

22nd June, 1892.

11,647. PNEUMATIC CHECKS for DOORS, B. Mountain, Yorkshire.
11,648. SHARPENING SLATE, &c., PENCILS, A. F. Small, London.
11,649. CARD SCORING MACHINES, J. Grumner and R. Osborn, London.
11,650. RAILWAY SIGNALS, J. Samuel and A. G. Horne, Glasgow.
11,651. BURNERS for HYDRO-CARBON LAMPS, D. Glen, Glasgow.
11,652. TURNING LATHES, A. Robertson and Loudon Brothers, Glasgow.
11,653. TOBACCO PIPES, C. F. Ould, Liverpool.
11,654. WHEELS for BICYCLES, &c, T. G. Jelly, Birmingham.
11,655. WEIGHING APPARATUS, S. Bankier, Glasgow.
11,656. VALVES, J. Barr, Glasgow.
11,657. FLOAT VALVES, J. Barr, Glasgow.
11,658. WINDOW BLIND CORDS, F. Lea, Bradford.
11,659. WATERING and SANDING MACHINE, B. D. Healey, Preston.
11,660. CYCLE RIMS, &c., A. M. Linney and R. J. Topp, Bedworth.
11,661. MOTIVE POWER, J. Lavers and P. H. Stansfield, Bradford.
11,662. COATING METAL PLATES, &c., T. I. Williams, Swansea.
11,663. HEARTH BRUSH, F. J. Cheesbrough.—(*B. Strobel, Germany.*)
11,664. TUBULAR ELECTRIC CONDUCTORS, E. Payne, London.
11,665. SARDINE CASE OPENING KNIFE, J. H. Cam, Sheffield.
11,666. PULLING COTTON, J., R., and J. Greenhalgh, Manchester.
11,667. RIDING and DRIVING REINS, R. H. Clapham, London.
11,668. FURNACE BARS, W. Mellor, Manchester.
11,669. CHIMNEY POTS, R. Wylde, Manchester.
11,670. MOISTENING GUMMED SURFACES, C. Darrah, Manchester.
11,671. CAR COUPLING, A. Minter, London.
11,672. ARMATURES, R. E. B. Crompton and S. L. Brunton, London.
11,673. SURGICAL DRAINAGE TUBES, H. Brown, Glasgow.
11,674. BISCUIT TINS, W. McFadyen, Glasgow.
11,675. APPARATUS for use in FEATS of STRENGTH, G. Mulhall, London.
11,676. MONEY RECEPTACLES, &c., C. A. S. Browne, London.
11,677. RAILWAY SIGNALS, B. S. Barton, London.
11,678. MAKING of KNITTED STOCKINGS, W. P. Thompson.—(*A. Auwärter, Germany.*)
11,679. HAIR COMBS, J. A. Crowther and J. H. Goodall, London.
11,680. CONNECTED SEATS of BICYCLES, J. A. Lamplugh, London.
11,681. NEEDLE THREADER, H. B. Bryan, Surrey.
11,682. CELLAR FLAPS, J. A. Wilmore, London.
11,683. SEPARATING MAGNETIC ORE from SAND, W. B. Basset, London.
11,684. CAN-OPENER, L. Silverman, London.
11,685. WARMING PLATES, FOOD, &c., R. W. Boyd, London.
11,686. COAT SUSPENDERS, B. Woodsford, London.
11,687. TOOL for DRAWING CRANKS &c., off AXLES, G. T. Ferrell, London.
11,688. VELOCIPEDES, G. E. Marshall, London.
11,689. NIPPLES for BABIES' BOTTLES, A. M. Small, London.
11,690. INDICATOR MECHANISM for WEIGHING MACHINES, J. H. Booken, London.
11,691. TASMANIAN OILS, H. L. Sharp, jun., and J. R. Causton.
11,692. ELECTRIC LOCOMOTIVES, F. Purdon, H. E. Walters, B. Mott, and J. P. O'Donnell, London.
11,693. STOP MECHANISM, W. E. and F. R. White, and A. Mills, London.
11,694. EVAPORATING APPARATUS, F. W. E. G., and F. W. Scott, jun., London.
11,695. SEWING MACHINE NEEDLES, T. Wise, London.
11,696. MANUFACTURE of GLASS BOTTLES, B. A. Spaull, London.
11,697. PRINTING UPON RIBBONS and TAPES, L. Corner, London.
11,698. INSULATORS for OVERHEAD WIRES, F. Meyer, London.
11,699. RAQUET BALLS, F. T. Prosser, London.
11,700. TOBACCO PIPES, H. D. Cape, London.
11,701. TOY and ADVERTISING MEDIUM, D. Whitburn, London.
11,702. EFFECTING AUTOMATIC TRANSLATION, E. Raymond-Barker, London.
11,703. OPENING DOORS, H. E. Newton.—(*E. M. T. Rodden, New South Wales.*)
11,704. GENERATING STEAM, H. E. Newton.—(*E. A. Ashcroft and J. Howell, New South Wales.*)
11,705. DISTILLING, &c., ACIDS of LIQUIDS, E. J. Barbier, London.
11,706. BICYCLES, and other VEHICLES, J. T. Mayor, London.
11,707. SEWING MACHINES, D. Jones, London.
11,708. GAS ENGINES, G. Hitchcock and J. A. Drake, Sheffield.
11,709. TUBES for PEN-HOLDERS, R. Blanckertz, London.
11,710. TUBES for PEN-HOLDERS, R. Blanckertz, London.
11,711. MANUFACTURE of FURNITURE, L. Cambier, London.
11,712. MOULDING STIFFENINGS of BOOTS, H. H. Lake.—(*W. J. Young, United States*)
11,713. TREATMENT of METAL PLATES, H. H. Lake.—(*E Norton, United States.*)

23rd June, 1892.

11,714. FIRE-ARMS, F. Beesley, London.
11,715. SWEEPING MACHINE for ROADS, A. C. Holms, Belfast.
11,716. RAFT and BOAT for NAVIGATION, F. McNamee, Dublin.
11,717. REFRIGERATORS, R. B. Horne and D. Collins, London.
11,718. DRIVING MOTION for VELOCIPEDES, H. Hodgson, Yorks.
11,719. IMITATION WINDOW CURTAIN, R. Stafford, Newcastle-on-Tyne.
11,720. CHIMNEY TOPS, D. Curr, Manchester.
11,721. SUPERHEATERS, W. Schmidt, Sheffield.
11,722. PULLEY-BLOCKS, H. L. Lister, Sheffield.
11,723. GRINDING REVOLVING FLATS, W. H. Richardson, Manchester.
11,724. DRYING, &c., SEWAGE SLUDGE, &c., J. W. Lodge, Yorks.
11,725. WRINGING and MANGLING MACHINES, H. Beswick, Manchester.
11,726. BOILERS, J. Langfield and R. B. Sharples, Manchester.
11,727. ANCHORS, F. D. Taylor, Birmingham.
11,728. DRIVING GEAR for BISCUIT MACHINERY, J. Vicars, T. Vicars, and J. Vicars, Liverpool.
11,729. "GAS-FIRE" BODY, J. Scott and H. Darwin, Glasgow.
11,730. COTTON GINS, B. A. Dobson.—(*R. Roscoe, India*)
11,731. TRAVERSE MOTION of CALICO PRINTING MACHINES, T. Thorp and J. Holgate, Manchester.
11,732. BOLTS for DOORS, &c., W. Neilson, Birmingham.
11,733. STOPPERS for BOTTLES, E. Carver, Birmingham.
11,734. CARBONITE, J. M. Stuart and F. Webb, London.
11,735. ELECTRIC DYNAMO MACHINES, J. Swinburne, Teddington.
11,736. DISTRIBUTING PAMPHLETS, T. Lees, Ayr, N.B.
11,737. RAILWAY STOP-BLOCKS, C. Lawrence, Bristol.
11,738. CHANNEL and COPING with SPECIAL SHAPED GRIDS, F. C. Lynde, Manchester.
11,739. PHOTOGRAPHIC CAMERAS, J. R. C. Gale, Surrey.
11,740. WOVEN FABRICS, W. Noble, Manchester.
11,741. MAKING CARTRIDGE CASES, A. C. Wright, Birmingham.
11,742. EXTRACTORS for STUFFING BOX GLANDS, T. E. Wilkes, Portsmouth.
11,743. PROPULSION of VEHICLES, C. Platt, G. Esdaile, and K. T. Sunderland, Manchester.
11,744. TEXTILE BANDS for DRIVING SPINDLES, K. M. Clark, Glasgow.
11,745. LOCK BOLT and NUT, T. James, Liverpool.
11,746. STEAM BOILER STOPPER, A. Wallace, Glasgow.
11,747. FIXING of TILES to CEILINGS, &c., J. Dobbie, Glasgow.
11,748. CYCLES, H. J. Lawson, London.
11,749. CYCLES, H. J. Lawson, London.
11,750. CASES for LOCKS and LATCHES, D. K. Elton, London.
11,751. REFRIGERATORS, W. Donaldson, London.
11,752. TURNING-OVER LEAVES of MUSIC, H. S. Rayner, London.
11,753. MEANS for BLASTING by EXPLOSIVES, F. Pfeiffer, London.
11,754. SHOES, J. Smith, London.
11,755. PEDALS of VELOCIPEDES, R. Caswell, jun., London.
11,756. RAILWAY COUPLING, J. Hastie and S. C. Brown, Kingston-on-Thames.
11,757. ATTACHMENT for WALKING-STICKS, R. Ransom, London.
11,758. EMBOSSING WOOD, G. Staber and H. Abbey, London.
11,759. COLLAR-STUD, E. S. Smith, London.
11,760. CISTERN VALVE, A. E. Shaw, London.
11,761. COMBINED CHIME MUSICAL CLOCK, L. J. Smith, London.
11,762. IGNITION APPARATUS for GAS MOTORS, E. W. Cooper and R. H. Lea, London.
11,763. SPRING MOTORS for WHEELED VEHICLES, F. Rühs, London.
11,764. EXTINGUISHER for LAMPS, W. P. Noldwritt, London.
11,765. TREATMENT of SEWAGE SLUDGE, W. Webster, London.
11,766. HARDENING STONE, W. H. Talbot and C. H. Venning, London.
11,767. APPARATUS for SEPARATING ORES, F. Baum, London.
11,768. EFFECTIVE SELF-ACTING COW MILKER, G. Gould, London.
11,769. MECHANICAL JACQUARD LOOMS, J. U. Niederer, London.
11,770. EASELS, G. Brain, London.
11,771. CUTTING FRUIT, A. J. Boult.—(*A. Tätzner, Germany.*)
11,772. PNEUMATIC TIRES, C. K. Welch and H. du Cros, London.
11,773. EMERY WHEELS, H. H. Lake.—(*A. Johnston, United States.*)
11,774. RIDDLE for AGRICULTURAL PURPOSES, T. and R. Stewart, London.
11,775. SUSPENDING DEVICE for HATS, E. C. Kunady, London.
11,776. COUPLING for RAILWAY WAGONS, J. H. Escolme, London.
11,777. CORD HOLDER or GRIPPER, C. E. Bulling, London.
11,778. CANISTER for STORING SYRUP, E. F. Griffin, London.
11,779. CARBONS for LAMPS, G. F. Redfern.—(*C. Braun, Germany.*)
11,780. NARROW FABRICS, I. F. J. St. J. de Valles, London.
11,781. BRUSHES, E. A. Glazier, London.
11,782. CHILD'S UNDERGARMENT, G. D. McKay, London.
11,783. SHADE, W. E. Lord, London.
11,784. GRAPE and other FRUIT WINES, F. Chavauty, London.

24th June, 1892.

11,785. DRAWING INSTRUMENTS, J. F. Bennett and E. P. Hides, Sheffield.
11,786. THREAD THROWERS, T. Holmes, Nottingham.
11,787. DISTILLING SEA WATER, S. Smillie, Glasgow.
11,788. FRICTION CLUTCH, J. R. Churchill and F. G. S. Woodville, Woodford.
11,789. STEERING CARD INDICATORS, W. B. Barker, London.
11,790. CANE BASKETS, F. Heinrich and H. Richter, Glasgow.
11,791. BALING PRESSES, J. and N. Blezard, Manchester.
11,792. MACHINE for WASHING WOOL, T. H. Shaw, Bradford.
11,793. FURNACES, W. Welford, Sunderland.
11,794. INK PROTECTOR PENHOLDER, J. Mauerberger, London.
11,795. ATTACHING HANDLES to BRUSH STOCKS, J. Thomson and T. Dykes, Glasgow.
11,796. FORKS for SPREADING MANURE, J. Firth, Keighley.
11,797. LOOM SHUTTLES, H. Jackson and C. Holt, Rochdale.
11,798. TEAPOTS and WATER JUGS, G. Castleden, Framlingham.
11,799. NIGHT SIGHT for SMALL-ARMS, &c., E. A. Down, London.
11,800. INCOMBUSTIBLE COMPOSITION, J. Scott and H. Darwin, Glasgow.
11,801. CENTRAL SCREW STEAMSHIPS, C. Harris, Brighton.
11,802. HORSE-HOES, C. Lea, Silverdale.
11,803. ROUNDABOUT RAILWAYS, G. Robson, Sunderland.
11,804. DIRECT-ACTING SCREW PROPELLER, N. D. Spartali, Cardiff.
11,805. WHEELS for VELOCIPEDES, &c., J. Gardner, Manchester.
11,806. MOTOR, W. P. Ellis, Hooley Hill.
11,807. METERS for MEASURING ELECTRICITY, R. Kennedy, Glasgow.
11,808. MECHANICAL STOKERS, J. Y. Johnson.—(*J. Belleville, France.*)
11,809. CARBURATING APPARATUS, S. Marcus and E. F. Bothe, London.
11,810. ROTARY ENGINE, S. Marcus and E. F. Bothe, London.
11,811. FIRE-GRATES, S. Marcus and E. F. Bothe, London.
11,812. STEEL FRAME for PHOTO-PRINTING, J. Donnelly, London.
11,813. WATER-CLOSETS, S. B. Dix, Cheltenham.
11,814. COVERS and FRAMES for MANHOLES, T. Crapper, London.
11,815. PIPES and CIGAR HOLDERS, &c., A. S. Bull, London.
11,816. FILTERS, B. M. Santurio, London.
11,817. DISTRIBUTING THEATROPHONIC AUDITIONS, B. Marinovitch and G. Szatvady, London.
11,818. LAMPS, A. J. Boult.—(*J. B. F. Frestureau, France.*)
11,819. RIDDLING DEVICE for SIFTERS, T. W. Jones, Liverpool.
11,820. BAGS, The Rothwell Hosiery Company and W. Rothwell, Manchester.
11,821. HINGE, O. and H. Smith, London.
11,822. ELECTRICALLY WINDING CLOCKS, H. Aron, Liverpool.
11,823. MEASURING ELECTRIC CURRENTS, H. Aron, Liverpool.
11,824. TIRES for WHEELS of CYCLES, &c., I. Sagar, London.
11,825. SWINGS, J. and J. R. Meakin, London.
11,826. CHARGES for AERATING LIQUIDS, G. Bamberg, London.
11,827. OBTAINING MOTIVE POWER, H. M. Fellows and A. R. Whitham, London.
11,828. TREATMENT of WASTE LIQUIDS, A. T. Hall and G. C. Robinson, London.
11,829. HEATING WATER, A. Fitt, London.
11,830. COMBINED HANDLE and FASTENING for BOXES, S. E. Wills, London.
11,831. PORTABLE CASES for ARTISTS, S. E. Wills, London.
11,832. BEDROOM INDICATOR, F. Arenas, London.
11,833. SHIP RAILWAYS, A. M. G. Sébillot and F. Weidnecht, London.
11,834. SUPPORTING SLIDING DOORS, T. C. Prouty and C. W. Turner, London.
11,835. TANNING HIDES, E. J. Finot, London.
11,836. BOOK RESTS, H. P. Clemetson, London.
11,837. LOCK NUT WASHER, P. A. Craven, London.
11,838. TOBACCO POUCH, H. Kaufman, London.
11,839. BULLETS, C. King, J. M. Stuart, and F. Webb, London.
11,840. TROUSER CLIP, F. Beauchamp, London.
11,841. CUT-OFF VALVES, G. V. Putman and L. Caten, London.
11,842. STOPPING SHIPS, W. H. Davies, London.
11,843. UMBRELLAS, C. Machin, jun., London.
11,844. HEATING APPARATUS, O. Schulze, London.
11,845. FIRE BRIDGES, H. Boettger, London.
11,846. ACCORDIONS, P. Stark, Germany.
11,847. LINING for MOUTHS of BOOT-JACKS, C. Unger, Germany.

25th June, 1892.

11,848. FILLING or BOTTLING MACHINES, J. Meadowcroft, Blackburn.
11,849. BRANCH BOXES for ELECTRIC CIRCUITS, S. Bergmann, Glasgow.
11,850. SYRUP FILTRATION, J. B. Thwaites, London.
11,851. ADVERTISING, B. Tree, London.
11,852. VENT PEG, G. Upton, jun., London.
11,853. RETURNING WATER to BOILERS, F. E. Blackmore, Reading.
11,854. SEPARATING METALS, W. L. Wise.—(*A. E. Woolf, United States.*)
11,855. DRESS STAND and DRAPING PAD, E. H. Lodger, Shrewsbury.
11,856. TOILET PAPER HOLDERS, J. W. Bennet, London.
11,857. INDICATING the FORCE of a KICK, A. Barr, Glasgow.
11,858. WINDOW SASHES, T. Downie, Glasgow.
11,859. HOLLOW TIRES of BICYCLES, I. A. Read, Birmingham.
11,860. SHUTTLES for LOOMS, H. Cruse, Manchester.
11,861. TABLE for SURGICAL PURPOSES, E. G. Payne, London.
11,862. PARING MACHINES, W. Robinson and G. Shipley, Leicester.
11,863. WATCH CHAIN BARS, R. F. Macauley, Glasgow.
11,864. FOLDING, &c., TOILET PAPERS, L. Platnauer, Bristol.
11,865. NAPHTHALENE SULPHO ACIDS, B. Willcox.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
11,866. TRUNKS, W. P. Eglin, Halifax.
11,867. PRODUCTION of PICTURES, G. T. Teasdale-Buckell, London.
11,868. KEYS, &c., for SECURING RAILS, G. Seater, Sheffield.
11,869. PORTABLE CAMERAS, V. Dunkerley, London.
11,870. FLUSHING BASIN for CLOSETS, W. Briggs, London.
11,871. SHIRTS, G. Remmer, Sheffield.
11,872. COVERINGS for the FEET, W. H. Blackwell, Manchester.
11,873. SCRIBBLERS, &c., E. and W. H. Crowther, Halifax.
11,874. MANUFACTURE of CARPETS, B. Fielden, Halifax.
11,875. MAPS, G. Cinquemani, London.
11,876. COLOURING MATTERS, B. Willcox.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
11,877. MEASURING SUBSTANCES, C. F. Hausmann, London.
11,878. NEW ATTACHMENT for WATCHES, R. E. Pigott, London.
11,879. NEW TRAP for VERMIN, E. C. Butterworth, London.
11,880. COUPLINGS for CARRIAGES, F. W. Leipnitz, London.
11,881. STEPS, C. Pilgrim, London.
11,882. BRAKE for PERAMBULATORS, T. H. B. Hitching, London.
11,883. RESTORING the HUMAN HAIR, R. Madewell, London.
11,884. FIXING PULLEYS, T. S. Payne and C. Polybank, London.
11,885. MONEY BOXES, T. M. Houghton, Hersham.
11,886. DEVICE for PROTECTING FLAT IRONS, J. Genn, London.
11,887. AERATING LIQUIDS, S. and S. S. Walker, London.
11,888. CORNICE POLES, TONKS, Limited, and W. H. Tonks, jun., London.
11,889. PRODUCTION of POTASSIUM CARBONATE, P. Römer, London.
11,890. BOOTS and SHOES, L. Derréal, London.
11,891. SAWS, W. and C. Junge, London.
11,892. GAS ENGINES, E. L. Burne, London.
11,893. STIPPLING INSTRUMENT, J. B. Pabl and J. G. Gaudelas, London.
11,894. UNICYCLES, J. Imlah and G. Patterson, London.

11,895. KEY-ACTION of ACCORDIONS, E. Kalbe, London.
11,896. REMOVING HAIRS from RABBIT SKINS, W. R. Cameron.—(*C. Graf, New Zealand.*)
11,897. WHEELS and AXLES, A. J. Boult.—(*C. Lüders, Germany.*)
11,898. RACE RESULTS PRINTED QUICKLY, A. MacPherson, Liverpool.
11,899. TRANSPORTING SALT, &c., H. Armstrong and A. Main, Liverpool.
11,900. BICYCLES, W. V. Biggs, London.
11,901. COTTON YARN, A. J. Boult.—(*P. Bivenet, Belgium.*)
11,902. THILL COUPLING, C. L. Fischer, London.
11,903. HAIR-CUTTING MACHINE, D. Rylands and H. Kelly, Shepcote, near Barnsley.
11,904. FERRULE for WALKING STICKS, &c., A. Pollak, London.
11,905. BEDS for INVALIDS, J. Eggert, London.
11,906. GLASS DISHES, T. Davidson, London.
11,907. RAILWAY FOG SIGNALLING, W. Varney and E. G. Jukes, London.

27th June, 1892.

11,908. CONSTRUCTION of CHECK TILL, G. H. Gledhill, Halifax.
11,909. COIN-FREED DRAWER for MONEY, G. H. Gledhill, Halifax.
11,910. FIRE-LIGHTERS, J. T. Holmes, Bradford.
11,911. WIRE ROPE FASTENER, H. Sykes and E. Jackson, London.
11,912. ARM SHIELD for CYCLISTS, J. Haley, Bristol.
11,913. TOBACCO PIPES, J. Sharpe, London.
11,914. BLEACHING of COTTON, W. Crippin and C. O. Weber, Manchester.
11,915. DYEING RED on COTTON, W. Crippin and C. O. Weber, Manchester.
11,916. DYEING BLACK on COTTON, W. Crippin and C. O. Weber, Manchester.
11,917. ENVELOPE, F. H. Judd, London.
11,918. CLEANING GRASS SEED, W: McCausland, Glasgow.
11,919. ADVERTISING, G. Smith, Sheffield.
11,920. FITTINGS of PNEUMATIC TIRES, R. F. Hall, Birmingham.
11,921. HOLLOW METAL INGOTS, G. Hatton, Brierley Hill.
11,922. BELLOWS ACTION for CAMERA SHUTTERS, R. Aspa, Leamington Spa.
11,923. POLYCYCLE, W. C. Burton, Latchford.
11,924. COVER for PNEUMATIC TIRES, T. Kimber, London.
11,925. LACING BOOTS and GAITERS, J. Fergusson, Glasgow.
11,926. EYE LENS, A. J. Stuart, Tunbridge Wells.
11,927. RING LENS, A. J. Stuart, Tunbridge Wells.
11,928. GAS ENGINES, W. Le P. Webb, Cheltenham.
11,929. IMPROVED BALL-BEARING, H. O. A. E. Grünbaum, Stratford.
11,930. SECURING BAGS, F. J. Beaumont and H. F. I. Hallows, London.
11,931. CYCLE MUD GUARD, A. Govan, Glasgow.
11,932. STRAIGHTENING UNDRESSED WIRE, J. E. Walsh, London.
11,933. POSTING NEWS CONTENTS BILLS, J. Tufnail, Newbury.
11,934. DISPLAYING ADVERTISEMENTS, T. A. Allen, Manchester.
11,935. LATHE, C. M. Linley, London.
11,936. STARTING GEAR for GAS ENGINES, D. Clerk, Birmingham.
11,937. NON-CORROSIVE COMPOSITION PAINT, R. Michell, Truro.
11,938. STRAINER ATTACHMENT for POTS, F. Hancock, Buralem.
11,939. BEDROOM RUG, F. Armitage and W. Hirst, Huddersfield.
11,940. SECURING TIRES, W. C. Ackland and W. C. Mudge, Southampton.
11,941. METERS, H. W. Miller, London.
11,942. PEDAL ZITHER, G. Schömig and P. Stiess, London.
11,943. SEPARATING GRAIN from IMPURITIES, N. Heid, London.
11,944. SEPARATING GRAIN from IMPURITIES, N. Heid, London.
11,945. BRAKE MECHANISM, E. G. Brewer.—(*J. D. Georges, France.*)
11,946. AUTOMATIC FEEDER HOPPER, J. H. Rowden, London.
11,947. VALVES, T. W. Barber, London.
11,948. CIRCUIT-CONTROLLING THERMOSTAT, &c., H. Cortland, London.
11,949. AUTOMATIC CUT-OFF, A. J. Boult.—(*E. Deane, Canada.*)
11,950. PUMP for FORCING WATER, J. Pilecka, Manchester.
11,951. ASCERTAINING LEVEL of FLUID, J. D. Churchill, London.
11,952. ELECTRIC METERS, J. W. Jones, Balham.
11,953. HEELS for BOOTS and SHOES, H. Menier, London.
11,954. SECURING MILK CANS to BUILDINGS, J. R. Breame, London.
11,955. WORD or NUMBER CHART, W. M. Gilmore, London.
11,956. AUTOMATIC SPRINKLER, A. W. and L. A. Edwards, London.
11,957. SHIELDS for GUNNERS, J. E. Emerson and T. Midgeley, London.
11,958. WOVEN COVERINGS for TIRES, E. Turrall, London.
11,959. MANUFACTURE of PIPES or TUBES, F. J. Clinch-Jones, London.
11,960. MEANS for LOCKING NUTS or BOLTS, J. Evinof, London.
11,961. LUBRICATORS, D. Doody, London.
11,962. ENGINES, J. W. Hornsby, R. Edwards, and W. E. Gibbon, London.
11,963. COIN-FREED APPARATUS, W. S. Simpson, London.
11,964. TREATMENT of WHEAT, G. Broom, J. Harvey, and S. H. Loynes, London.
11,965. SUSPENDERS for GARMENTS, C. G. Meyer, London.
11,966. TRANSPORT by HYDRAULIC POWER, H. de M. Snell, London.
11,967. CHROMATIC PRINTING MACHINES, Sir R. H. Wyatt.—(*J. A. Barratt, United States.*)

28th June, 1892.

11,968. STOPPING MOTION of LOOMS, W. Ratcliffe, Manchester.
11,969. TELEGRAPHIC COMMUNICATION between LIGHTSHIPS and the SHORE, J. H. Hirst, Kingston-upon-Hull.
11,970. DOOR and WINDOW FASTENER, J. N. Euwer, London.
11,971. STEW PANS, C. Turner and W. F. Weld, London.
11,972. MANUFACTURING CUBE SUGAR, W. Hannah and F. Curtis, London.
11,973. DOUBLE TIRE for BICYCLES, J. R. Earnshaw, Manchester.
11,974. CHECK MECHANISM for GAS METERS, J. L. Jones, Bristol.
11,975. CARRIAGE SEATS, G. T. Chestham, Bradford.
11,976. WRAPPER for BOTTLES, D. Storrar, Kirkcaldy, N.B.
11,977. FISHING-RODS, R. Bennett, Birmingham.
11,978. DATING PRESSES, T. J. Edmondson, Manchester.
11,979. INSERTING WIRE into LEATHER, A. G. Brookes.—(*J. W. Brooks, United States.*)
11,980. INSERTING WIRE into LEATHER, A. G. Brookes.—(*J. W. Brooks, United States.*)
11,981. NAIL-MAKING MACHINERY, A. G. Brookes.—(*J. W. Brooks, United States.*)
11,982. RAILWAY CURVE RAIL, J. G. Jordan, London.
11,983. PARTITIONS for DRAWERS, &c., A. J. Wells, London.
11,984. CLIP for FISHING LINES, &c., J. Heyland, Sheffield.
11,985. ELASTIC TIRES for BICYCLES, W. Giffard, Salford.
11,986. CONVERTING HEAT into WORK, J. H. Parkinson, London.
11,987. CLEANING BOILER FLUES, P. S. Kingsland, Glasgow.
11,988. PRESERVING MEAT, J. Y. Johnson.—(*H. Salzer, United States.*)
11,989. PROCESS of PURIFYING WATER, C. G. Collins, Glasgow.
11,990. SCIENTIFIC TOYS, J. R. Hughes and D. R. Rees, London.
11,991. MARINE ENGINES, W. C. Wallace, Glasgow.
11,992. COMBINATION FEED-WATER HEATER, &c., E. Nelson, Manchester.
11,993. SECTIONAL SURFACE CONDENSERS, E. Nelson, Manchester.
11,994. RECOVERY of the CLOTH from DAMAGED WATERPROOF FABRICS, T. J. Hutchinson and R. B. Hardman, Manchester.
11,995. HORSESHOES, J. Gutmann, Manchester.
11,996. STEAM ENGINES, J. M. Anderson, London.
11,997. MECHANISM for ACTUATING SIGNAL WIRES, J. Fisher, Matlock.
11,998. FLOWER-POTS, A. Taleyrac, London.
11,999. MACHINES for MAKING STRANDS, W. H. H. Sisum, London.
12,000. WOVEN METALLIC MATERIAL, W. Pitt, London.
12,001. ANEROID BAROMETERS, L. Comitti, London.
12,002. COMBINATION ARTICLE, F. Hawker and H. T. Brown, Birmingham.
12,003. BOOT RECEPTACLE, C. B. Chapman and L. W. Goold, Birmingham.
12,004. NEW GAME, H. A. Pryor, London.
12,005. CALCULATING MACHINES, M. Hearn, London.
12,006. PEDALS for CYCLES, F. Shelton, G. W. G. Booker, and D. Brazier, London.
12,007. ENVELOPES, E. M. Pearson, London.
12,008. METALLIC SASH LIFTS, &c., R. G. Evered, London.
12,009. ADDRESSING MACHINES, F. D. Belknap, London.
12,010. CYCLE BELLS, P. Schilling, London.
12,011. REAPING MACHINES, W. Fullard, London.
12,012. PIPE SUBWAY, S. Spratt and F. Bailey, London.
12,013. REAPING MACHINES, J. Hornsby, J. Innocent, and I. Trolley, London.
12,014. LOCKS and BOLTS for DOORS, J. Wedderburn, London.
12,015. MARINER'S COMPASSES, R. Oliver, London.
12,016. WHEEL TIRES, W. R. Lake.—(*H. Myers, United States.*)
12,017. SMOKE-CONSUMING FURNACES, G. S. Riley, London.
12,018. BOOMERANG GUNS, W. R. Lake.—(*C. H. Emerson, United States.*)
12,019. DRIVING APPARATUS for CONTROLLING HORSES, E. Martin, London.
12,020. CUTTING RAGS, J. Nuttall, London.
12,021. TEA STRAINERS, F. J. Wills, London.
12,022. CURRY COMBS, C. J. Schweim and W. Schweim, London.
12,023. HOLLOW RUBBER TIRES for VELOCIPEDES, T. B. Jeffery, London.
12,024. SQUARE PAPER BAGS, T. B. Powell, London.
12,025. RAILWAY RAILS, O. Imray.—(*The Johnson Company, United States.*)
12,026. RAILWAY RAILS, O. Imray.—(*A. J. Moxham, United States.*)
12,027. CROSSINGS and SWITCHES, O. Imray.—(*The Johnson Company, United States.*)
12,028. EXPANSION JOINTS of RAILWAY RAILS, O. Imray.—(*A. J. Moxham, United States.*)
12,029. REGULATING PHOTOGRAPHIC SHUTTERS, H. Hill and A. L. Adams, London.
12,030. SEPARATING METALLIC SUBSTANCES, C. Raleigh, London.
12,031. SEPARATING METALLIC SUBSTANCES, C. Raleigh, London.
12,032. STAMP BATTERIES, C. Raleigh, London.
12,033. TYPEWRITERS, C. Raleigh, London.
12,034. TURNING OVER MUSIC LEAVES, J. H. Butcher, London.
12,035. FOLDING BEDSTEADS, H. Stevenson, London.
12,036. STAMPING PRESSES, W. R. Comings and A. A. Righter, London.
12,037. WATCH KEYS, H. F. C. Goetz and S. Glasgo, London.
12,038. APPARATUS for DISPENSING LIQUIDS, W. M. Fowler, London.
12,039. ELECTRIC RAILWAYS, T. Floyd, London.
12,040. ARC ELECTRIC LAMPS, J. E. A. Gwynne, London.
12,041. CLOTHES PEG, G. A. Farini, London.
12,042. PENHOLDERS, H. Bilin, London.
12,043. BENDING STRAWBOARD, &c., T. Remus, London.
12,044. AUTOMATIC SUPPLY of ELECTRICITY, G. H. Jones, London.
12,045. CHIMNEY or VENTILATING SHAFT, M. Goodwin, London.
12,046. SEWING MACHINE for HATS, W. P. Gammons, jun., London.
12,047. WRITING PENS, T. A. Ward, London.
12,048. ROWING BOATS, W. Pendlebury, London.
12,049. PRESERVATION of RAILWAY SLEEPERS, G. H. Culling, London.
12,050. CLIP for FASTENING CUFFS to SHIRTS, J. Hanson, London.
12,051. MOTORS for UTILISING LIQUIDS, H. Oehlschlaegel, London.
12 052. BELL PUNCH for MARKING TICKETS, D. McGill, London.
12,053. TYPEWRITERS, A. J. Boult.—(*J. A. Watson, United States.*)
12,054. EXTRACTING HEAT from STEAM BOILERS, T. Mudd, Liverpool.
12,055. MUSICAL INSTRUMENTS, F. Pietschmann, Liverpool.
12,056. BOTTLES, W. Smith, Liverpool.
12,057. PRINTING TELEGRAPHS, S. R. Linville, London.
12,058. GULLEYS, J. W. Wild, Liverpool.
12,059. THREADING PIPES, W. P. Thompson.—(*J. B. Z. Dumais, United States.*)
12,060. CURE of FOOT-ROT in SHEEP, W. P. Thompson.—(*G. G. and S. B. Gayman, United States.*)
12,061. LOCKING DEVICE, A. J. Boult.—(*H. Lentz, Germany.*)
12,062. SUNSHADES, UMBRELLAS, &c., C. A. Whipple, London.

29th June, 1892.

12,063. INCREASING the VALUE of SALT, G. Weddell, Newcastle-on-Tyne.
12,064. SPRING-BACK MUSIC STOOL, A., R., and H. Leveson, London.
12,065. BENDING METAL PIPES or TUBES, H. P. Penby, Leeds.
12,066. GAS BURNER, J. Scott and H. Darwin, Glasgow.
12,067. "GAS FIRE" BODIES, J. Scott and H. Darwin, Glasgow.
12,068. CUTTING-OFF the INGRESS of STEAM, W. Ackroyd, Halifax.
12,069. FIRE ALARM, F. Perry, Margate.
12,070. VALVE GEAR, W. J. Llewellyn and J. Bate, Birmingham.
12,071. WATER SERVICE PIPES, W. H. Pick, Bradford.
12,072. TEAPOTS, J. M. Young, Glasgow.
12,073. CURTAIN CARRIER for BAY WINDOWS, W. Robertson, Alnwick.
12,074. PNEUMATIC TIRES for BICYCLES, J. Bradley, Manchester.
12,075. FILLING POTS with JELLIES, &c., J. Robertson, Glasgow.
12,076. REPRODUCING PICTURES, W. H. McLaughlin, Lancashire.
12,077. FIXING ENDLESS ELASTIC BANDS, R. Middleton, Leeds.
12,078. RECEIPT BOOKS, J. Watts, Manchester.
12,079. SPIGOT and FAUCET JOINTS, J. Wotherspoon, Glasgow.
12,080. PREVENTION of PUNCTURING in PNEUMATIC TIRES, A. G. Nicholas, Warrington.
12,081. FRICTION and PULLEY CLUTCH, W. Ambler and W. J. Warren, Leeds.
12,082. AUTOMATIC SCENT FOUNTAIN, J. H. Wharton, Lancashire.
12,083. FLUSHING CISTERNS, J. A. and J. H. Jackson, Manchester.
12,084. BETTER PROTECTION of LETTER-BOXES, W. H. Halliwell and A. F. Wilkinson, Brighton.
12,085. DOUBLE-BARREL GUNS having ONE TRIGGER, S. J. Wallis, Birmingham.

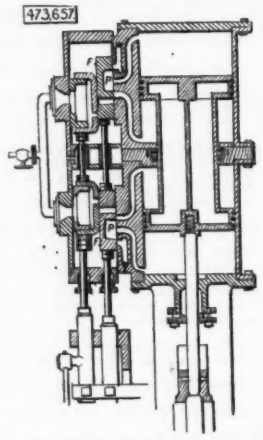
SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

473,657. ENGINE, *M. B. Dodge, San Francisco, Cal.*—*Filed July 1st*, 1891.

Claim.—In an engine, the separate and independent cylinders, with independent valve chambers in connection therewith, said cylinders being secured together in line with each other, an intermediate removable head having a chamber and packing rings removably fitted therein, pistons fitting each of the cylinders, a trunk connecting said pistons passing through the intermediate head of the cylinder and the packing rings, ports connecting each of the cylinders with its independent steam chest, and exhaust ports leading from the outer ends of each of the steam

473,657

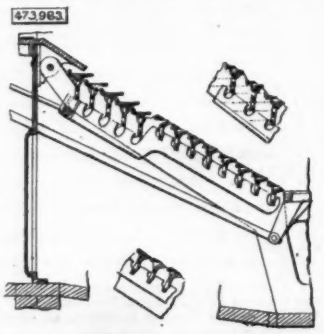


chests, valves F, having chambers P, by which the inner and outer ends of the cylinders and the outer ends and exhaust passages are each alternately connected together, supply ports made through the extended inner ends of the cylinders, whereby steam from the boiler is admitted directly to the inner ends of the cylinders only, slide cut-off valves movable upon the backs of the main slide valves, and connecting rods extending through the intermediate walls of the valve chambers, whereby the slide and cut-off valves of each of the cylinders may be removed or adjusted independently of each other, substantially as herein described.

473,963. GRATE, *W. R. Roney, Chicago, Ill.*—*Filed June 30th*, 1891.

Claim.—An inclined grate consisting of horizontally arranged grate bars having inclined top surfaces and depending webs or flanges, said grate bars having

473,963



openings or slots extending horizontally from their inclined faces to their rear or outer surfaces, and the depending webs or flanges being provided with longitudinal slots or openings arranged opposite said slots or openings in the grate bars, substantially as described.

474,028. MANHOLE COVER FOR STEAM BOILERS, *N. Newman, Springfield, Ill.*—*Filed June 10th*, 1891.

Claim.—The combination, with a boiler shell, of the separate right-angled plate united thereto and having the joint between itself and the shell rendered steam-tight by calking, and the cover fitted within the plate, with the exposed face of the same flush with

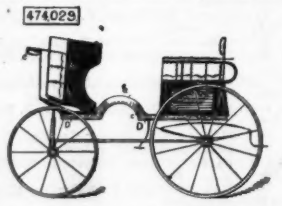
474,028

the plate and having its inner edge doubled or folded upon itself and forming a groove or channel which receives the flange of the plate, the joint between the plate and cover being rendered steam tight by caulking the same, and the leakage of steam and packing being obviated by fitting the cover within the plate, as set forth.

474,029. CARRIAGE, *A. N. Parry, Amesbury, Mass.*—*Filed November 24th*, 1891.

Claim.—(1) A carriage body formed with an upward curve, termed a wheel house, and having the sides thereof set inward from the side sills, so as to be narrower than the full width body when the doors

474,029

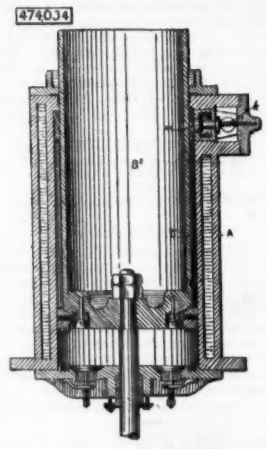


are opened, but when they closed constituting a full width body, substantially as specified. (2) In a carriage body, the side sills *a* of the wheel house set inward from the sills D, as shown at *c*, and a projection *e*, formed upon the front seat to open and close the space between the inner face of the door and the end of the wheel house, substantially as specified.

474,034. AIR COMPRESSOR, *B. F. Teal, Chicago, Ill.*—*Filed March 30th*, 1891.

Claim.—(1) In a compressor for gaseous fluid, the combination of an outer cylinder and a piston therein, the latter comprising a trunk and a head forming, with the cylinder, an initial compression chamber at the face of the head opposite that carrying the trunk and between the cylinder and trunk, an annular space affording a final compression chamber, the said piston operating by its successive strokes alternately to introduce the gas at normal pressure into the initial compression chamber and to compress it thence from one side of the head into the initial compression chamber at the opposite side of the head, substantially as described. (2) A compressor for gaseous fluid, com-

474,034

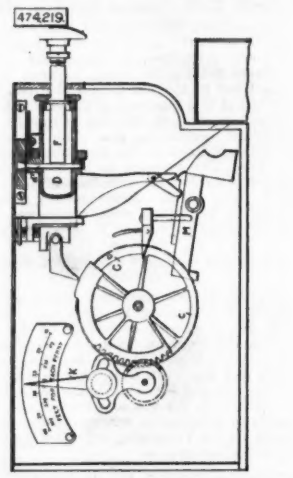


prising, in combination, a cylinder **A**, containing a piston B, formed with a head B' and trunk B², an annular chamber C between the piston and cylinder, controlled by a check valve *m* between the said chamber and its outlet *k* and controllably communicating with the inlet end of the cylinder, and inwardly opening check valves in the piston head and adjacent cylinder head, the whole being constructed and arranged to operate substantially as and for the purpose set forth.

474,219. COIN-FREED GAS METER, *W. Govan, Edinburgh, Scotland.*—*Filed January 8th*, 1892.

Claim.—(1) In a coin-controlled gas meter, the combination of a wheel adapted to permit the passage of a predetermined quantity of gas through the meter at each revolution thereof, a reciprocating coin-receptacle carrying a pawl engaging said wheel to impart a uniform partial rotation to said wheel at each reciprocation thereof, a pawl, a pusher sliding in said coin-receptacle and adapted on insertion of a coin to actuate said receptacle and rotate the wheel to admit a predetermined quantity of gas through the meter, a movable index for regulating the rotation of the wheel by the said pawl, mechanism for automatically stopping the flow of gas through the meter, and a guard for preventing the withdrawal of a coin from the coin-receptacle, substantially as described. (2) The combination of the wheel C for controlling the

474,219

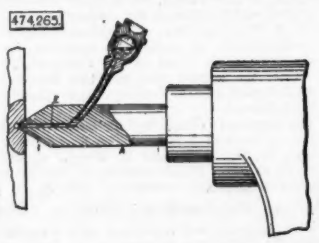


passage of the gas through the meter, the reciprocating coin-receptacle D, provided with the transverse coin-slot d^3 and carrying at its end the pivotted pawl E, engaging the wheel C, the pusher F, sliding in the coin-receptacle, the adjustable index K, engaging the wheel C and adjustably regulating the rotation of said wheel by the said pawl, and the detent M for automatically stopping the meter, substantially as described. (3) The combination of the wheel C, the reciprocating coin-receptacle D, carrying the pawl E, engaging said wheel, the spirally-grooved tube Q, the sliding pusher-rod F, carrying the pin q^2, travelling in the spiral groove q^1, and the adjustable index K, substantially as set forth.

474,265. LATHE CENTRE, *W. C. Roe, Honolulu, Hawaii.*—*Filed July 7th*, 1891.

Claim.—A lathe centre A, having a conical point, a longitudinal central bore E, leading from the point inward and outward through the centre at a rearward

474,265



incline, a removable lubricating receptacle having an outlet tube entering said inclined portion of the bore and the distributing groove I, leading from the point of the centre along its conical portion, substantially as set forth.

EXPERIMENTS IN CYLINDER CONDENSATION.

MR. BRYAN DONKIN, JUN., nas been for some time carrying out a series of experiments of great interest in Bermondsey. These experiments are intended to supply much-needed facts which may help to the preparation of a trustworthy theory of the steam engine. Both in this country and abroad there is manifested a tendency to reason on assumptions which may or may not be founded on fact. As a rule, the writings of foreign philosophers have no true foundation whatever; and most elaborate mathematical formulæ have been prepared to explain and account for what does not really exist. Obviously the only way to learn fully and completely what takes place in the cylinder of a steam engine is to witness the phenomena through its walls. Many attempts have been made to construct engines with glass cylinders; none have been more than partially successful. It is practically impossible to fit a steam-tight piston inside a cylinder which is never quite true, and the glass cracks on very small provocation. A couple of years ago Mr. Donkin endeavoured to get over the difficulty by fixing on an engine cylinder cover a glass vessel in which condensation and re-evaporation could be seen to take place, just as they did inside the metal cylinder; but the results were not as instructive as was desirable, because it was very difficult to make any quantitative experiment with the apparatus. To get over this objection, Mr. Donkin has fitted up in the engine house of the Bermondsey works an experimental apparatus, which is competent to give quantitative information. The results have not yet been fully worked out; indeed the investigation is still in progress, and we do not feel ourselves at liberty to give more than a few general particulars; but these will, we think, be found of very great interest not only to the engineer but to the physicist. It must be clearly understood, however, that Mr. Donkin is in no way responsible for the deductions which we have drawn from them. For the present he reserves all expression of opinion.

The engine-house in question contains a compound beam engine, making about fifty revolutions per minute. On the wall of the engine-house is fitted up the experimental apparatus, which consists in brief of a glass cylinder about 4in. in diameter and 4in. long. There is a top and bottom metal plate, between which and two india-rubber rings the cylinder is held in a vertical position, small bolts and nuts drawing the plates together and making with the india-rubber rings steam-tight joints with the glass. Cylinders of various dimensions and material can be used. Steam is led from the boiler to a very simple arrangement of valves, worked by a lever from the engine parallel motion. Steam is admitted to the glass cylinder, cut off sharply, and allowed to exhaust, just as though there was a piston in the glass cylinder, which there is not. A small surface condenser is provided, and by turning a couple of taps and making no other change the glass cylinder can be worked at pleasure condensing or non-condensing. Steam is supplied by a small branch from the main steam pipe. Underneath the horizontal portion of this branch is placed a row of gas jets, and by lighting these the steam supplied to the glass cylinder can be superheated by about 30 deg. The pressure used can be regulated to anything—from 5 lb. up to 50 lb. on the square inch. A gas flame and a reflector are placed behind the glass cylinder to enable what goes on inside to be seen. Delicate thermometers can be introduced, and there are complete arrangements for measuring the condensing water and its rise of temperature, and for draining off and measuring any water which may accumulate in the cylinder.

We have here, then, conditions identical up to a certain point with those which exist in the clearance space of a steam engine, and there is no difficulty in watching the phenomena. The steam enters in the centre of the upper end of the cylinder, and a minute's observation suffices to dispose of the idea that thin uniform films of moisture accumulate on the cylinder walls. On the contrary, we see that a species of hurricane rages within the cylinder. The moment the steam valve opens there is an in-rush which blows all the water remaining in the cylinder in every direction. The interior of the cylinder is filled with a storm-tossed cloud. Water quickly deposits itself in big drops on the glass, some of which drops run down to the bottom. The exhaust opens, and the clouds disappear like magic; violent ebullition takes place, and a good deal of water disappears, and so the process is continued stroke by stroke. The first point almost to strike the observer is that under no circumstance do the surfaces inside the cylinder become wholly dry. Condensation and ebullition take place alternately; but there are always drops of water on the glass and metallic surfaces. These neither increase nor diminish in quantity. So far we have spoken of nothing more than might be expected to happen. Mr. Donkin has indeed already made the world tolerably familiar with the phenomena we have briefly described. But the matter does not end here. To begin with, it might be supposed that the presence or absence of a vacuum would greatly influence the results. But this does not appear to be the case. The ebullition which goes on when the exhaust opens is more pronounced, but so far as can be seen the formation of cloud and the deposit of water in drops on the cylinder walls is about the same in both cases. Again, it might be concluded that by superheating, the steam condensation would be wholly averted. Nothing of the kind. It is diminished, but not entirely got rid of; and yet it is very puzzling to understand how and why condensation can take place when the steam contains so large a reserve of heat. But the most remarkable phenomena of all is, we think, the way in which condensation takes place. The glass cylinder is fitted with a small indicator, by the aid of which diagrams may be taken in the usual way. Thanks to Mr. Donkin's courtesy, we are enabled to place before our readers examples of these diagrams. At first sight they may easily be mistaken for ordinary indicator diagrams taken from an engine with good valve gear. Of course, this is a mere coincidence. The glass cylinder is filled with steam, and the valve closes at the point marked A in Fig. 1. The great bulk of the condensation has taken place during this admission period. If no further condensation took place, then the line B A would be prolonged, as shown by the dots. As a matter of fact, however, the instant steam is cut off the pressure falls, and goes on falling to about half the initial pressure, as shown by the diagram. It will be understood that the curve is not an expansion curve, because the capacity of the cylinder remains unalterably the same, and the condensation is not due to liquefaction resulting from work, because there is no work done. If our readers who chance to possess a power diagram of about the same dimensions and cut-off will make a tracing of it and put it on top of Fig. 1, they will see how large is the influence that cylinder condensation may have on the shape and area of a diagram. The expansion curve would probably be not far off the lower dotted line in Fig. 1, and our readers can form their own conclusions as to how far $pv^n = a$ constant is likely to represent what really takes place in a steam engine cylinder, or how far it is possible to fix on any value

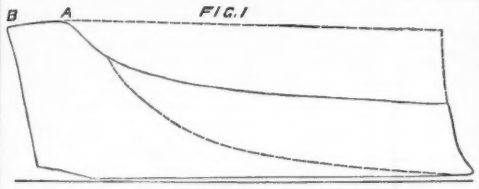


FIG. 1

which will be generally useful for x. Fig. 2 was taken when the cylinder was worked with the condenser. The initial pressure was lower. It will be seen that the condensation curve is about the same as in Fig. 1. The curve is in both cases anomalous. Assuming that the cylinder walls have to be heated up after the steam valve was closed, it is fair to think that the drop in pressure due to condensation would move more nearly in a straight line, gradually falling. Indeed, if we look at Fig. 2 it will be seen that after the first sudden descent in pressure, the liquefaction time curve, as we may call it, is very nearly such a straight line as we speak of. It is by no means easy to form any satisfactory theory which will at one and the same time account for the sudden drop to begin with, and then for the continuous nearly

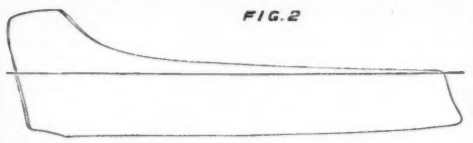


FIG. 2

straight line. Either can be accounted for alone consistently enough. It is the combination which is puzzling. The solution of the difficulty lies probably in the fact that heat is travelling *in* through the cylinder walls and *out* at the same time in different parts of the thickness of the metal or glass. Thus we find that the mercury in a thermometer, placed with its bulb in the thickness of the metal cylinder end, is always a little behind the mercury in a thermometer with its bulb immersed directly in the steam. The mercury rises and falls in both, through a considerable range at each stroke. It must suffice, however, merely to mention this fact. Mr. Donkin will, no doubt, have much of great interest

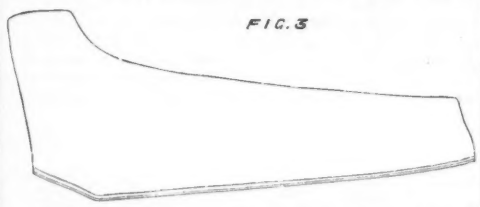


FIG. 3

to tell his hearers concerning the travel of heat in cylinder walls.

We have on a previous occasion stated that there is reason to think that liquefaction may take place in steam from another cause than the direct abstraction of heat, and we have mentioned facts which lead to the inference that whenever the flow of steam is suddenly arrested, or it is made to beat against obstructions, or suddenly to change its volume, liquefaction may be induced. We venture to think that Mr. Donkin's experiments tend to support this opinion. It is reasonable to say that if steam be superheated no cylinder condensation ought to take place. It is worth while to consider a little more in detail what Fig. 1 implies. It must be clearly understood that the whole cylinder is open to boiler steam, during the time marked by the length of the line B A. It is during this period that by far the greatest liquefaction takes place. The whole inside of the cylinder is warmed up to the same temperature as the steam. The conditions are in no wise the same as those which obtain in a real steam engine with expanding steam following a quickly receding piston, and continuously opening up new surfaces of cold iron. In the case under consideration we have—we must once more point out—a vessel of fixed capacity, and the time during which full pressure steam is admitted seems to be sufficient to heat up this vessel pretty thoroughly. If, now, superheated steam is brought into contact with the cylinder walls, then much more during the time A B, Fig. 1, ought they to be so far raised in temperature that they will not subsequently drop enough to cause much condensation. That is theory. Let us see what practice tells us. Fig. 3 is a diagram taken with the condenser on and all the conditions nearly the same as Fig. 2, with the exception that the pressure was higher, and the gas jets having been lighted some time, the steam was superheated, being about 20 degrees hotter than the temperature normal to the pressure. It will be seen, however, that this superheating has had no effect whatever on the liquefaction curve. That is just as pronounced in Fig. 3 as in Figs. 1 and 2. But, notwithstanding this, the superheating effects a very great economy, but only because it diminishes liquefaction *during the period of admission*. Furthermore, Mr. Donkin has an arrangement by which he substitutes a gun-metal cylinder for one of glass, and this can be heated externally with gas jets. Under even these most favourable circumstances, with superheated steam, the drop in pressure after the steam valve closes is well marked, although not so great as in the diagrams we have reproduced. The plausible explanation is that the exhaust valve leaks; but Mr. Donkin is far too skilful an experimenter to use leaky valves, and during our visit there was certainly no trace of leakage.

We make no attempt to explain the phenomena we have described; our readers can find in them plenty on which to exercise their ingenuity. We shall await with interest the complete publication of Mr. Donkin's facts and figures and inferences. It is to such labours as his that the world must look for the solution of the strange problems which the steam engine presents, rather than to men who sit in their studies and elaborate theories out of their own internal consciousness, with the aid of much mathematical knowledge and some cogitation concerning what are known as "The Ought To Be's."

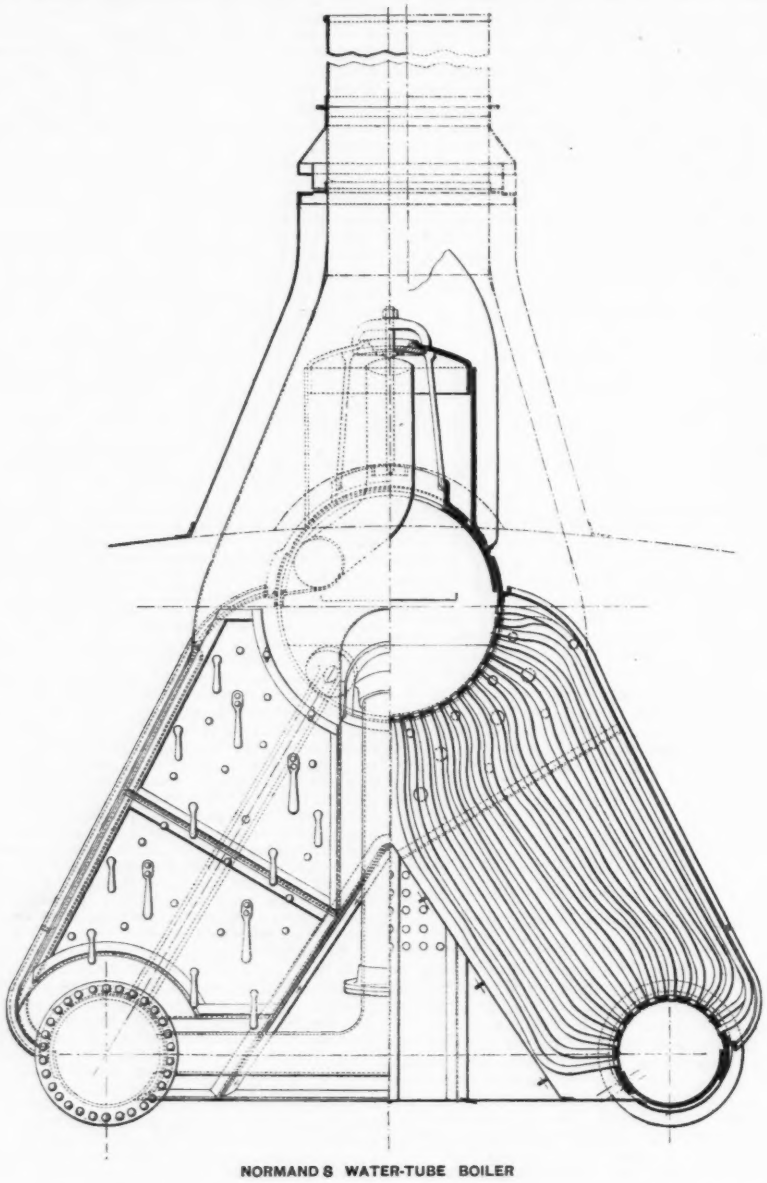
WATER SUPPLY OF PARIS.

EVERY year, during the hot days of summer, a great deal of uneasiness is felt by the inhabitants of Paris as to the efficiency of their water supply. Just at the time when they have most need of an ample supply of pure drinking-water, the springs of the Vanne do not yield sufficient to satisfy one-tenth of the requirements. Generally, this difficulty is overcome by shutting off the spring water from one or two arrondissements only; but this year, owing to the persistent drought, nearly the whole of Paris has been deprived of the only water that is fit to drink. They have as much as they need supplied to them; but it all comes from the Seine, and the appearance of the river during the height of summer is anything but pleasant to those unhappy mortals who have to drink what is drawn from the foul and sluggish stream. The consumers of Seine water are certainly recommended to take every precaution in the way of boiling and filtering; but this is of little use in view of the inefficiency of the majority of filters sold, and of the fact that the poor classes, who constitute such a large part of the population, are unable to buy them. In order to economise the spring water as much as possible, the Municipal Council has just adopted some new rules which have been submitted by the Prefect of the Seine to the Minister of the Interior. The Municipal Council insists, in the first place, upon the adoption of meters. It has also resolved upon a reform in the tariffs. At present the charge is in inverse ratio to the consumption, and the larger the amount of water used the smaller is the charge per hectolitre made for it. It is evident that such a scale weighs heavily upon the small consumer to the profit of manufacturers, for instance, who use considerable quantities of water. Moreover, the big consumers, by this gradually reduced scale of payment, would have no incentive to economise their supplies. Under the new system each inhabitant will be supplied, at a moderate charge, with sufficient to satisfy his normal requirements, and beyond this quantity the amount consumed will be charged for upon an ascending scale. Each inhabitant will have fifty litres a day, and any surplus will be looked upon as a luxury, for which higher prices have to be paid. Besides having the effect of economising the spring water, this new scale will bring into the municipal treasury £64,000 a year more than it receives at present, and of this sum £40,000 will be set aside to pay off the loan for the carrying out of the new works now in course of construction. Already considerable progress has been made with the laying down of conduits and the construction of reservoirs at St. Cloud, for the bringing of fresh water to Paris. When in the course of three or four years these are completed, Paris will be as well supplied as most other capitals of Europe, instead of being, as at present, so badly off for water as to be a positive invitation to an outbreak of cholera or typhoid fever during the hot weeks of summer. In the suburbs to the west of Paris a great deal of attention is being paid to the water supply. It is here that the epidemics generally arise, and it is rare that a summer passes without some cases of cholera being declared. Works are now being laid down to supply this district with filtered water from the Seine, and in two months' time it is expected that plenty of water will be available for Suresnes, Courbevoie, Nanterre, Rueil, Asnières, Colombes, Bois-Colombes, Bezons, and Gennevilliêrs. The water will be conveyed from the Seine for a distance of 4000 metres to a reservoir at Suresnes, which is being constructed under the direction of M. Montupet, at a cost of £40,000. The bottom of the reservoir will be composed of layers of stones and sand, having a thickness of 80 centimetres, and in order to facilitate the renewal of these layers, the reservoir will be provided with two large iron gates. The completion of this work will do much towards removing a serious danger from a very large and populous district.

RAPID SIGNALLING BY ELECTRIC SEARCH-LIGHT.—The statement made by the *Times* and other daily papers, that, in the event of Lord George Hamilton being returned for the Ealing Division of Middlesex, the result would be signalled over the whole of the division, simultaneously with the announcement being made by the returning officer at Ealing, by two of Ronald Scott's well-known search lights of 30,000-candle power each, was successfully carried out in every detail. The two projectors were placed on the roof of The Elms, Mr. Scott's residence at Acton-hill, which is at about the same level as St. Paul's. Before the returning officer had finished his announcement both beams of light were sweeping the country round. One search light was then manipulated to signal the actual figures into Acton, and on to Chiswick at the same time, the signalman at Chiswick being stationed at the top of the Fire Brigade Tower, a distance of two and a-half miles from the source of light. The majority was first signalled, and then the numbers polled by each candidate; but, although accurately signalled and read, the signalman at Chiswick was so astounded by the enormous majority of Lord George Hamilton, that he awaited confirmation by bicycle from Ealing before giving out the result. The time occupied in transmission was less than four minutes.

A FRENCH TORPEDO BOAT.

M. Normand is determined that the French fleet shall have torpedo boats equal, if not superior, in speed to those possessed by any other nation, and he unquestionably does not lack skill, inventive power, or mechanical instinct to aid him in his task. The performances of his latest boat, No. 149, are too remarkable to be passed over in silence. This boat, which made her official trial at Cherbourg, is 118ft. long on the load water line, 13ft. 1½in. beam, and 8ft. 8½in. deep, and her displacement is 76 tons. These are nearly the dimensions of the standard torpedo boats, Nos. 126 and 129, which have been for some time attached to the squadron under the command of Admiral Gervais, and have given no trouble whatever. But in No. 149 the lines of the hull have been slighly modified, and its depth increased by 15 per cent., although the draught of water remains the same. The augmented freeboard makes her, it is claimed, a better seaboat. No. 149 is propelled by a single triple expansion engine. The cylinders are, omitting small fractions, 16in. + 28in. + 31½in. × 18in. In our impression for Jan. 30th, 1891, we described and illustrated very fully M. Normand's engines. Those of No. 149 are practically identical with those to which we refer. They are provided with all M. Normand's improvements, including the compression safety valves on the high and intermediate pressure cylinders; automatic drain cocks—specially designed to prevent the lodgment of even the smallest quantity of water in any of the cylinders; filters to prevent the entrance of grease into the boiler, a "bouilleur" to make up lost feed-water, and a feed heater worked by steam from the second intermediate receiver. This last appliance is an improvement on those previously used by M. Normand, the coefficient of heat transmission being augmented in the ratio of 2⅓ to 1, as compared with previously made heaters. The result is, that the temperature of the feed is augmented, when the boat is running at full speed, from 194 deg. Fah., the highest temperature secured in previous boats, to 272 deg. Fah., the temperature of the heating steam being 289 deg. Fah., corresponding to a pressure—absolute—of 57 lb. on the square inch.



NORMAND'S WATER-TUBE BOILER

Torpedo Boat No. 149.—Official Trial on the Measured Mile, 7th May, 1891.

Duration of run.	Revolutions. By the counter.	Revolutions. Per minute.	Advance per revolution.	Speed in knots.	Pressures. Boiler.	First cylinder.	Second cylinder.	Third cylinder.	Vacuum.	Air pressure.	Temperature of feed.
H. M.			ft. in.		kilogs.	kilogs.	kilogs.	kilogs.	Cent.	mm.	Fah.
3 18	1,059	320·8	7 7	23·164	11·80	10·50	4·9	1·10	66	60	269
3 12	1,045	326·5	7 6	23·888	11·80	10·80	5·0	1·20	66	60	266
3 16	1,078	330 0	7 2	23·401	12 60	11·00	5·3	1·25	67·5	65	271
Averages..	—	325 95	7 4	23·585	171 lb.	154 lb.	72 lb.	17 lb.	26in.	2·4in.	269
Time of observations.	*Run of Two Hours.*										
H. 2·05	9,722	—	—	—	kilogs. —	kilogs. —	kilogs. —	kilogs. —	Cent. —	mm. —	Fah. —
2·20	14,718	333·1	—	—	12·1	11·1	5·10	1·20	67	65	115
2·35	19,683	331·0	—	—	12·0	11·0	5·50	1·25	67	60	115
2·50	24,641	330·6	—	—	12·5	11·0	5·45	1·20	67	60	115
3·05	29,738	339·8	—	—	12·5	11·3	5·60	1·25	67	60	115
3·20	34,900	344·1	—	—	12·5	11·2	5·70	1·25	67	70	115
3·35	40,025	341·6	—	—	12·5	11·5	5·50	1·30	67	65	117
3·50	45,172	343·1	—	—	12·5	11·5	5·50	1·30	67	65	117
4·03	50,423	350·0	—	—	12·6	11·7	5·70	1·35	67	65	117
Mean 2 hr.	40,701	339·17	7 7	24·510	178 lb.	169 lb.	79 lb.	18 lb.	26·3in.	2·5in.	273

The boat had just come out of dock, and her bottom was clean, and had received a coat of the regulation French naval anti-fouling composition. The water was smooth, and the weather fine, conditions favourable to the boat on the other hand, she had on board her full fighting equipment, and enough fuel to enable her to steam 1800 miles at a speed of 10 knots. Her displacement was 76·453 metrical tonnes, or a little over 75 tons. The area of her midship section was 3·246 square metres, or 34·5 square feet nearly. Her draught of water on starting was forward, 3ft. 5in.; amidships, 3ft. 10in.; and aft, 4ft. 2¾in. She burned during the two hours' run, when steaming at full speed, 2280 kilos. of briquettes, or in round numbers 4826 lb., during which time she ran a little over 49 knots. On the completion of the two hours' run she was taken again for three runs over the measured mile, when speeds of 23·047, 26·061, and 23·401 knots were attained, giving, with the averages obtained during the first three runs, a mean of means of 24·642 knots per hour. M. Normand is, we think, to be congratulated on a very considerable success. The boiler gave no trouble whatever, and was found to be, when opened for examination after the trials, in perfect condition.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.

The half-yearly meeting of this Association was held in the Cannon-street Hotel on Saturday, July 2nd, at 7 p.m., when the Vice-President, Mr. James Brown, occupied the chair. The balance-sheet for the past half-year was submitted and considered to be highly satisfactory. Some general business was then transacted, after which a paper was read by Mr. S. Alfred Varley, on "Energy and Inertia and their Relationship to Dynamo Electric Apparatus."

Mr. Varley stated that in dynamo electric studies we are confronted with the two principles of energy and inertia in a greater degree than in any other study, and the more capable we become of grasping a knowledge of those principles, the better we are likely to understand the action of the dynamo. He considered all physical arts were reducible to a duality, viz., energy the elementary property of all force, and inertia the elementary principle of all matter, as contrasted with the forces associated with and which enter into the structure of matter. The function of a machine is to transmit, and when necessary alter the potential of the energy transmitted; but the dynamo transforms as well as transmits, and dealing as it does directly with the primary principles concerned in all transmission, the dynamo transmits energy more completely than any other machine. The energy developed by a dynamo worked by a steam engine was transmitted originally from the sun to the earth, and then built up by vegetable vitality into architectural structures which are veritable store-houses, in which energy is stored in a manner analogous to that of a storage battery. In the fire-grate of the steam engine, the energy contained in coal becomes unlocked and transferred to the water in the boiler, which it converts into a high-pressure gas, developing in the cylinders of the engine mechanical energy, which, being brought under the influence of the dynamo, becomes transformed into electrical energy, and in this form it is capable of being transmitted to almost any distance through solid conducting matter. To understand the nature of electrical transmission, we are compelled to have recourse to analogy, and what we see in connection with heat distribution by the hot-water system helps us to do so. In a hot-water system, energy in the form of heat enters the system and is distributed by the water inside the pipes; but no water passes into or out of the system, and if we assume electricity to be part of the conductor itself, and that it is capable of setting up motion in it, then we obtain some sort of notion of the way electrical conduction is supposed to occur. What electricity really is it is impossible to say; but he was strongly of opinion that it is indissolubly associated with the structure of matter, and controls it, having in fact a somewhat similar relation to matter that the mind of man has to the human system. Force is always associated with matter, and forms a sort of duality with it, and physicists tell us that the forces are simple modes of motion. In a sense this may be regarded as a truism; but at the same time it is no explanation, and what forces really are is involved in mystery.

Inertia is the distinguishing feature of matter, and energy is the distinctive property of force. Inertia strives to maintain the *status quo*; energy endeavours to bring about change; energy is positive, and inertia is negative. And wherever we have a manifestation of energy we encounter inertia, in fact they are the complement of one another; and whenever a transformation of energy occurs, the immediate cause of such transformation is the inertia or inactive energy resisting the active or positive energy.

Mr. Varley showed some interesting experiments with a large magnet, and also illustrated the laws of motion by a model; and concluded an interesting paper by a description of the action of different modes of winding in the construction of dynamos.

Mr. Parker spoke in appreciative terms of the paper, and proposed a vote of thanks to Mr. Varley. This was seconded by Mr. Heath, and carried unanimously. Mr. Varley briefly returned thanks, and mentioned that he had had the honour of discovering the principle of the dynamo electric machine, and showed a photograph of his original machine, which was made in 1866.

RAILWAY MATTERS.

THE opening of the Natal and Orange Free State Railway was celebrated at Harrismith at noon on July 13th, amid much enthusiasm and general festivities. Competition is now keener than ever between the Natal and Cape lines to secure the Transvaal trade. On the 14th reduced rates on the Natal Railway came into force, and next day the Cape line will retaliate by a further reduction. The *Times* says the tariff war is becoming mutually ruinous.

THE first section of the North Cornwall Railway—from Launceston to Splatt—about to be opened for traffic, is eight miles in length, and has an intermediate station at Egloskerry. Camelford is expected to be reached in about eighteen months, but probably that is an outside estimate, and the station will be at Melorn about a mile from the village on the Boscastle road. The stopping place for Boscastle will, it is said, be at Halwell, about three miles from the popular seaside resort.

DURING the nine months ending the 30th September last 3376 accidents of all kinds occurred on the Indian railways, as compared with 2755 accidents in the corresponding period of the previous year, when the total length of railway lines was nearly fourteen hundred miles less. The greater number of the accidents reported were, of course, of a trivial nature; but several of them were serious, and involved loss of both life and property. In these accidents 52 passengers were killed, and 160 were injured; while 121 railway servants were killed, and 398 injured.

THE British Consul at Jerusalem, in his last report, refers to the progress of the Palestine Railway, which has now been in course of construction for the last two years. The concession was granted by the Porte in 1888 to a company styled "Société Anonyme Ottomane," having its headquarters at Paris, and the works, which were calculated to cost about £240,000, but which will probably exceed that sum, are being carried out by a firm of French engineers. A little over one-half of the line has now been constructed, and there is a prospect that the remainder will be completed in September or October next. The length of the whole line will be 54 miles, or 17 miles longer than the present carriage road. When the line is completed a branch will be made from Ramleh to Gaza, possibly, a contemporary says, with the object of forming a junction with a line from Egypt.

IN an article on the necessity for rapid transport in cities, the *Engineering Record* says:—"Street railways, horse, cable and electric, have done much in this direction. They have helped to shorten the hours of labour, and to enable many men to own their own homes, who otherwise could never have done so; but they have also increased some of the very evils which at first they seemed to mitigate. Mr. Clarke says, 'The better the services of the street railways, the faster does the city population grow; the more do the people ride; the greater is the congestion of traffic, and the louder the complaints of the public. The demand for rapid transit facilities increases faster than the supply. Everyone thinks that his own city is in the worst plight, and that the managers of its street railways are the meanest men on the face of the earth. But all large cities where time is of any value are now in like distress.'"

THE *Journal* of the German Railroad Union reviews the present position in Europe of narrow gauge railways, on the adoption of which, it thinks, any further considerable extension of railroads in civilised countries depends. In Germany, it says, the narrow gauge has received very different treatment in the different countries. Saxony was early in the field with 29½in. lines, and has continued to build them; Prussia has only begun to pay attention to the narrow gauge; Bavaria will have nothing to do with it; in the smaller German States it has fared better, especially in Hesse. At the close of 1890 the whole German Empire had 542 miles of narrow gauge railroad, with 618 miles of track and 352 stations—on the average little more than a mile and a-half apart. In Austria, though it early built the narrow gauge military line in Bosnia, the narrow gauge gained ground slowly, but it receives more attention now, especially in Styria, where a local line will soon be opened. Austria—not including Hungary and Bosnia—has about sixty miles of narrow gauge railroad.

THERE are 584 miles of narrow gauge railway in Belgium. Holland has had steam tramways for many years, and at the beginning of 1890, 304 miles of these were of narrow gauge —29½in., 3ft. 3⅜in., and 3ft. 6in.—and not quite so much of standard gauge. One of the cheapest of these lines, of 29½in. gauge, cost £5000 per mile, equipped. France of late years has built a great many narrow gauge lines; in 1880 the Government issued regulations for the construction of lines of 1 metre and of 75 centimetres gauge, but nearly all lines built are of the former. At the end of 1889 France had 1848 miles of the local lines termed "secondary railways," and of these 843 miles were narrow gauge lines. In Switzerland nearly all the mountain railways built of late years have narrow gauge. In England the Festiniog Railway has had no imitators, and in Ireland, where 93 miles of narrow gauge were built, any further extension of them is opposed. Norway has built little else than narrow gauge railways since 1862, and has now about 620 miles of them, against 372 of standard gauge; and about 930 of the 4600 miles of railways in Sweden are narrow; the gauges vary from 31½in. to 47¼in.

THE shops of the Harvey Steel Car Company, of Chicago, are very busy, having more work than they can attend to in the line of car repairs. The argument of the Harvey Company is that:—"Anyone who will look into the subject will be satisfied that a superior car can be made of 6in. steel I-beams for side and intermediate sills, and 12in. steel channels for each of the two centre sills. By making the end sills of 6in. steel beams flush at the top with the centre and side sills, the draught rigging can be placed just below the end sills and above the bottoms of the 12in. channels, and thus bring the line of draught within the sills. This makes one of the simplest and best continuous draught gears. For buffing blows the wooden deadwood, or buffing block, reinforced with a plate to receive the blows from the buffer stop of the drawbar, affords immeasurably greater durability than can be obtained with wooden sills. If, added to this, the buffer stop on the drawhead can be made to strike against the deadwood at least ½in. before the spring closes up, there would be a decided decrease in the cost of maintenance of the draught springs and attachments. Harvey cars now weigh about 5000 lb. each less than a wooden car of the same capacity.

THE special Rapid Transit Commissioners for New York City, appointed by the Supreme Court, have filed their report. It practically indorses the report made by the Rapid Transit Railroad Commissioners, which recommended a double-track tunnel or tunnels for the loop through the Battery, State and Whitehall-streets, tunnels with three tracks under Broadway, from Bowling-green to Vesey-street, with four tracks from thence under Broadway, a double-track road across Spuyten Duyvil Creek, and from thence to the city limits. For the east branch, tunnels with four tracks were proposed. The scheme recommended, backed as it is by engineers of character and experience, is undoubtedly practicable, though whether the numerous trains required can be run with certainty, and the high speeds desired can be obtained economically by electro-motive power may be open to question. The *Engineering Record* objects to "all such underground projects, advocating a viaduct through the city blocks with unrestricted light and ventilation, having a solid substructure which would admit of running the heaviest locomotives and trains at the highest rates of speed without limitation as to the character of motive power to be employed." The court will probably confirm the report of the commissioners, and if so it remains to be seen whether capital can be attracted to the construction of this underground system.

NOTES AND MEMORANDA.

THE London death-rate last week was 17·2 per 1000 annually, the average of the thirty-three great towns being 17·1.

IN a recent number of the *Comptes Rendus* is a paper on the non-realisation of the spheroidal state in steam boilers. It is a reclamation of priority, by M. de Swarte.

MR. W. B. CROFT, of Winchester College, writing to *Nature*, mentions a form of sensitive water jet which seems in some ways new. A thin jet, 5ft. high and arched so as to be 3ft. at the base, was falling in a feathery spray. At 13ft. distance a small Wimshurst machine was set going: not instantly, but after two minutes, the spray gathered itself up almost into one clear line: although the jet was turned up and down and the machine was discharged, the falling water would not resolve itself again into spray for fifteen or twenty minutes. It is difficult to imagine the medium for this action: it is too indefinite, perhaps, to suppose that an indicator is found for the trembling of a disturbed ether while it is lying down. The well-known experiment is not known enough, for it is not often described in books. Take a glass rod, electrified ever so little, to a certain point; at once the jet collects itself; a slight move away brings back the old disorder, while an inch nearer makes things much worse. It is a striking illustration to help one to imagine what the electrical forces of the air may do. We can, perhaps, understand those thick thundery rain-drops, that almost allow us to pass between them while they are giving friendly warning of what will come.

IN a paper recently read before the Paris Academy of Sciences on the co-existence of dielectric power and electrolytic conductivity, M. E. Bouty described a rigid condenser formed of iron discs separated by small wedges of mica, and joined by iron screws insulated by mica and placed opposite the wedges. This condenser is plunged into a fused mixture of equal parts of the nitrates of sodium and potassium. Air bubbles are carefully removed with plates of mica, and the condenser is withdrawn at the moment when the salt commences to solidify. The liquid, retained by capillarity, forms between the discs an adherent regular solid layer. The apparatus while yet hot is plunged into melted paraffin, which surrounds it with an insulating layer, devoid of hygroscopic power. The experiments give a value for k approaching 4, and nearly constant within the limits of temperature in which the specific resistance in ohms may vary from $3{\cdot}6 \times 10^{11}$ to $2{\cdot}6 \times 10^{9}$, *i.e.*, in the ratio of about 138 to 1. Here the conductivity and the dielectric capacity belong to molecules of the same kind. It is probable that if the experiments could be extended to ordinary electroylytes, they would give results of the same kind—that is, finite values of the dielectric constant k. The distinction between dielectrics and electrolytes would thus solely reside in the amount of their conductivity. Dielectric polarisation, established in a very short time in comparison with the ten-thousandth of a second, would correspond, in Grotthuss's scheme, to the initial orientation of the compound molecules, their conductivity to their progressive rupture.

IN a paper on "Magnesium as a Source of Light," the results of an investigation are summed up in *Nature* by Frederick J. Rogers, as follow:—(1) The spectrum of burning magnesium approaches much more nearly that of sunlight than the spectrum of any other artificial illuminant. (2) The temperature of the magnesium flame, about 1340 deg. C., lies between that of the Bunsen burner and that of the air-blast lamp, although the character of its spectrum is such as would correspond to a temperature of nearly 5000 deg. C., were its light due to ordinary incandescence. (3) The "radiant efficiency" is 13½ per cent., a value higher than that for any other artificial illuminant, excepting, perhaps, the light of the electric discharge *in vacuo*, for which Dr. Staub, of Zurich, has found an efficiency of about 34 per cent. (4) The radiant energy emitted by burning magnesium is about 4630 calories per gram of the metal burned, or 75 per cent. of the total heat of combustion, as compared with 15 per cent. to 20 per cent. in the case of illuminating gas. (5) The thermal equivalent of one candle-power minute of magnesium light is about 2·4 lesser calories, as against 3·5 to 4·0 for other artificial illuminants. (6) The total efficiency of the magnesium light is about 10 per cent., as compared with 0·25 per cent. for illuminating gas. (7) Taking into consideration the greater average luminosity of the rays of the visible spectrum of the magnesium flame, it is certain that per unit of energy expended, the light-giving power of burning magnesium is from fifty to sixty times greater than that of gas.

PRIOR to 1863 an export duty on iron ore from Bilbao was a complete barrier to trade in that material. In that year, however, the duty was abolished, and homeward cargoes for the few small British sailing vessels frequenting the port were obtained at a freight of 4s. per ton, and 58,560 tons, valued at £14,627, was exported. In 1867 the trade increased to an export of 137,000 tons, valued at £37,500, and in 1870 to 270,000 tons, valued at £83,000. From that year the trade commenced to assume importance, and in 1872, 496,000 tons, valued at £198,000, were exported. Then came the civil war and a total cessation of trade till 1876, when commercial transactions were resumed and 410,000 tons were exported. The disastrous effects of the war appear to have roused the Basques to fresh enterprise and activity; mines were opened in every direction, mineral lines of railway constructed, and in 1878 the export of iron ore increased to 1,224,730 tons, valued at £979,700. Since that period the trade has, with some fluctuations, continued increasing till it has reached the large armount of 4,372,918 tons, valued at current prices in the importing countries at £2,842,450, exported in the year 1890, of which the United Kingdom took 3,040,560 tons, or 70 per cent. of the total exportation, the chief importing ports in order of importance being Middlesbrough, Cardiff, Newcastle, Glasgow, and Newport, while the chief ports on the Continent were Rotterdam and Dunkirk. The new exterior port will soon be sufficiently far advanced to solve the problem of the effect which a splendid harbour, both for refuge and commercial purposes, may have on the future commerce of Bilbao; it is quite possible that this port may absorb a still larger proportion of the trade of the Peninsula than it has hitherto done.

AT a recent meeting of the Amsterdam Royal Academy of Sciences, Mr. Behrens dealt with specimens of brass made by compression of the constituents at ordinary temperature by Prof. W. Spring, Liége, Belgium. One of the specimens, kindly forwarded by Prof. Spring, was of a reddish colour, and had been produced by compressing a mixture of nine parts of copper and one part of zinc; another, pale yellow, by compressing a mixture of seven parts copper and three parts zinc. Both specimens had been filed up twice, and again consolidated by pressure. The reddish metal was a little softer than common cast brass; it could be somewhat flattened under the hammer. The yellow metal was harder than common brass, and brittle. Both varieties contain a great quantity of yellow alloy, which seems to be in an amorphous state, showing a uniform, finely granular appearance, without any vestige of the beautiful crystallites, so characteristic for copper-zinc alloys, obtained by fusion. Further, a good deal of angular fragments of red copper, some of them cracked and doubled up, with yellow threads between the red lumps and strands, and finally some zinc, angular fragments and threads, trending outwards and uniting near the curved surface of the cylindrical specimens. The metal is nearly, but not wholly compact. There is much that gives evidence of a flow in the yellow alloy and in the zinc, but nothing pointing to a truly liquid state of the alloy or one of its components. Relegation seems to be put aside, while there does not remain any doubt that zinc and copper have been intimately mixed and actually united by repeated filing and compression. *Nature* thinks one may venture to say, that a more complete union of metallic powders by compression will lead to alloys of most remarkable properties, and may give some alloys that cannot be produced by fusion.

MISCELLANEA.

MESSRS. G. BAILEY TOMS AND CO. announce that they have taken into partnership Mr. George Marrs, who has been with them for many years.

THE Dover Harbour Board accepted on Saturday last the tenders of Mr. John Jackson, of Victoria-street, Westminster, for upwards of £400,000 for the eastern arm of the new harbour at Dover. The work is to be commenced forthwith.

ON the occasion of the approaching Leyton and Leytonstone Fire Brigades annual fire brigade demonstration and competition, the Fire Appliances Manufacturing Company have offered one of their steam fire engines, completely equipped, costing £300, as a first prize, for the turn out wet drill event, by six men and one officer. Gold and silver medals will be presented to the winning brigade, as also a silver challenge cup, value £15.

AN international water commerce congress is proposed by the Chicago Exhibition authorities. An address has been issued to the friends of water commerce in all countries, and the subjects to be considered cover the whole range of river and harbour improvement, interchange of rail and water transportation, harbour plant and equipment, size, model and power of vessels for both ocean and inland navigation. The committee has asked for suggestions.

FROM a description of the manner of the destruction of the staging of the bridge over the Licking River at Newport, Kentucky, it appears that first a segment of the top chord, of two panels length, fell, destroying the traveller and the staging immediately under the traveller, as described in this page last week. Then the staging fell towards the breach. The immediate cause of the fall of the portion of the top chord which wrecked the traveller will probably never be known. If the staging had been braced longitudinally the wreck would have been much less extensive.

ON the night of June 17th, dam No. 2 of the Mahanoy City, Pa., Water Company broke, letting a flood of water into the valley below. An embankment of the Lehigh Valley Railroad Company checked the flow for a few minutes, and owing to this and the fact that the alarm was promptly given only one life was lost. Much property was destroyed. The water supply of Mahanoy City is by gravity from four impounding reservoirs. The dam which failed was of puddled clay with no heart wall. Its length is not known, but it was 130ft. wide at the bottom and 25ft. wide on top. The inner slope was paved and the outer covered with large stone. It had a bywash excavated in earth and lined with stone, and held back about 3,000,000 gallons of water. There was a 6in. discharge pipe with a valve at both ends.

AT the Manchester City Council on Wednesday, Sir John Harwood, one of the Corporation directors of the Ship Canal, said in answer to questions that the dredging of the Canal was difficult, and there were other matters of uncertainty, such as the awards under impending arbitrations, which must delay the promised report on financial prospects. The Canal could not possibly be opened before the end of next year, and it would need more money than the three millions the Corporation had already got power to advance, but he did not think the sum would be so great as some people seemed to imagine. The engineers were being urged to complete their statistics. He regretted that the Canal had been laid with such great foundations, as otherwise the money already spent would have brought ships to Manchester by now.

JUDGE COXE, of the United States Circuit Court, New York, who seems to have before him the most celebrated patent cases, has recently rendered a decision that will have a good deal of value to the Accumulator Company there, and the Pacific Electrical Storage Company in San Francisco. The decision was a suit against the New York and Harlem Railroad Company, and involved the perforated plates, confirming to the Accumulator Company their right to that invention, which is essential in the construction of plates that will endure. It means, in a mechanical sense, "rivetting," or clinching the plastic material on each side of the plates by means of perforations enlarged or tapering each way from the centre. The Electrical Accumulator Company have expended a great deal in defending their patents, which, it is reasonable to be supposed, have been infringed up to the "danger line," and construed in as barren a sense as possible to favour later inventors. Judge Coxe, says *Industry*, will become an engineer and mechanic in due time if his Court continues to deal with such cases.

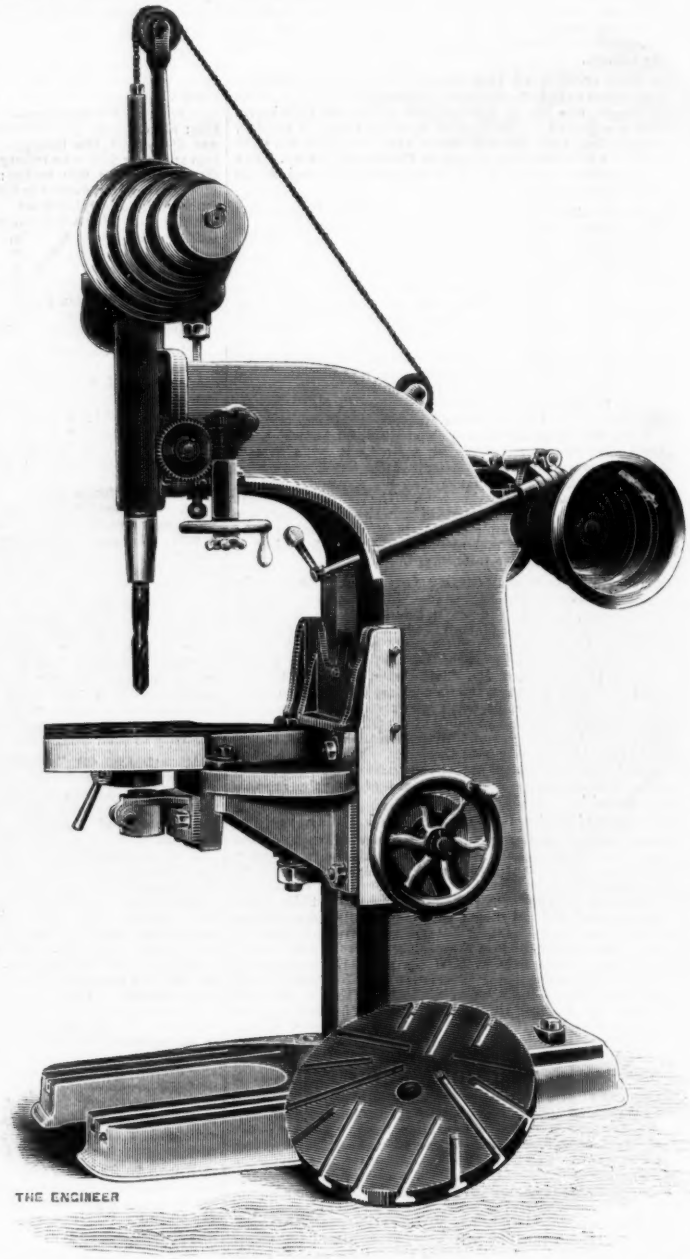
AT Renfrew the hopper dredger Triton has just been launched from the yard of Messrs. W. Simons and Co. for the Government of Ceylon. The vessel entered the water with steam up and ready to commence its trials. It was constructed to the design and under the direction of Messrs. Coode, Son and Matthews, civil engineers, of Westminster, and Mr. Wilson Wingate, naval architect, London, supervised its construction on their behalf. This dredger is intended to deepen the port of Colombo to 36ft. depth of water. Its hopper compartments have a capacity for over 500 tons of dredgings. The dredging wheel gear is made chiefly of steel, and friction gear is provided to prevent undue strains coming on the dredging machinery. Triple-expansion engines of 600 indicated horse-power and two steel boilers of 150 lb. working pressures, and steam steering, and steam starting and reversing gear are provided. The cabins of the officers and crew are suited for a warm climate, bath rooms being also provided. As the Triton left the ways the naming ceremony was performed by Miss Grace Rowan Wingate, of London.

EARLY this month the death took place of Mr. Edward Manlove, who was for over half a century a prominent figure in the commercial life of Nottingham. Mr. Manlove was born in Nottingham in 1807. Over sixty years ago he was a draper in the Market-place, and afterwards a bleacher at Lenton Works. While there the present engineering business was established, in partnership with the late Mr. Alexander Alliott, principally for the introduction of the then newly-invented centrifugal machine or hydro-extractor. The business increasing necessitated the building of the now well-known Bloomsgrove Works at Radford, about forty years ago, when Messrs. Manlove and Alliott left Lenton and retired from the bleaching business. Since then the engineering business at these works has greatly increased, and is now one of the largest and most important in the Midland Counties, giving constant employment to an average of 500 or 600 men. About four or five years since the business of Manlove, Alliott, and Co., was converted into a limited liability company, and from then up to the time of his death Mr. Manlove was chairman of the board of directors.

THE British Consul at Cherbourg—Mr. Vereker—in his last report mentions the extraordinary growth in the trade in macadamised stone between that port and this country. This export, which in 1890 increased tenfold over 1889, has trebled from 1890 to 1891—when it amounted to nearly 30,000 tons—and, still in its infancy, is, he says, capable of almost unlimited expansion. Much, however, remains to be done to give it legitimate impulse; it is imperative that a tramway be established from the quarries in the Montagne du Roule to the shipping quays, thus avoiding the expense and delays of cartage from the quarries; that cranes be erected on the quays so as to insure rapid shipments; and that more powerful and effective machinery be erected at the quarries. A concession has been granted to the French company for constructing railways of secondary importance, to lay a tramway along the Rue du Val de Saire, from the point where it meets the road from the quarries and round the quays; the lessees of the quarries have agreed to construct a tramway from the quarries to meet that to the quays, and it is hoped that during the present year the work will be completed, and thus considerably promote the exportation of macadamised stone.

DOUBLE-GEARED DRILLING MACHINES

MESSRS. DOUGLAS FRASER AND SONS, ARBROATH, ENGINEERS.



DOUBLE-GEARED DRILLING MACHINES.

The accompanying engravings illustrate tools made by a firm which, although little known in the trade, has had an extended experience in the construction of tools in their own special works in the textile line. We think the two designs are attractive in appearance. The tools are extremely rigid in work, and adapted for twist drills and exactness. The double gearing, which is the same on both, is arranged to act direct on the spindle. It is compact and almost noiseless in working, and can be instantly changed from single to double by one motion of a hand wheel. The spindle is balanced by a weight, and is carried in a long sleeve which supports it, and gives, at its lower end, the downward thrust to the spindle through adjustable ball bearings. The thrust on the spindle of the hand feed wheel is also received by adjustable ball bearings. The table of the pillar machine is raised and lowered by a screw sunk into the side of the pillar, and that of the machine having the V sliding surfaces, by means of a movable rack and pinion. The table of this machine combines the advantage of swinging with that of rising on V slides. This is of value when boring, for example, with a boring bar, for which a bush is provided. The work may be adjusted with the swing table, and then readjusted for height during the progress of the work. There is ample length of belt on the cone pulleys, and these are placed at a very convenient height from the floor; there is less chance of accidents happening thereby in shifting the belting. Unlike the ordinary type of drilling machines, these may be set facing to the shop shafting.

THE BRUCE ELECTRICAL WAR BALLOON.

Mr. Bruce exhibited the action of his electrical balloon on Thursday evening, July 7th, at Stamford-bridge grounds, Fulham-road, before Prince Edward of Saxe-Weimar and a number of officers and others interested in the question. The balloon is designed to enable a system of electric signalling to be carried out at night under many conditions where signals made on the ground would not be visible. A system of electric lamps is suspended inside a translucent balloon. These are made to show light by an electric circuit, and thus signals are carried out on the Morse or any other system, which are, from their position in the air, very conspicuous. Mr. Bruce exhibited a model of his system in the Inventions Exhibition of 1885, and a Government trial was then made of the system by the Royal Engineers at Chatham, which was sufficiently successful to lead to further experiments at Aldershot, under Major Thrupp, the late inspector of Army signalling. In spite of a snowstorm the signals were read and answered. In 1887 the Belgian Government adopted the system, and attention was further attracted on the Continent. At the present time our Government have the plant for signalling to a limited extent. The trials on Thursday night were conducted with a view of bringing to public notice various improvements in detail which have come in since the first introduction of the system.

The balloon employed was stated to be 18ft. in diameter, and to contain 3200 cubic feet, but it appeared to be much smaller than this—hardly 12ft. in fact; possibly some error exists here. However, this is not a material matter. The balloon was made of varnished cambric, and contained six lamps worked to 16-candle power or 20-candle power. The six lamps take about nine ampères, the electro-motive force required being 24 volts. The battery consists of twenty-six cells of the Electrical Power Storage Company E 7 type. The improvements mainly consisted in the reduction of weight throughout the apparatus, especially in the ladder-like frame which carries the lamps inside the balloon, and in the flexible cable, which we understood weighs about 35½ lb. per 50ft. length. It consists of two wires, or rather two lines, each made up of many strands of wire, which two lines are laid in an india-rubber insulating coating and covered with tape, &c. This line would bear fairly rough usage, which is necessary. We imagine a wheel passing over it in the dark is a contingency which might occur on service. This it would bear no doubt well on fairly soft ground, and, perhaps, even on hard road or rock. Each electric cell now weighs only 24 lb. The key used is an improvement on the original pattern.

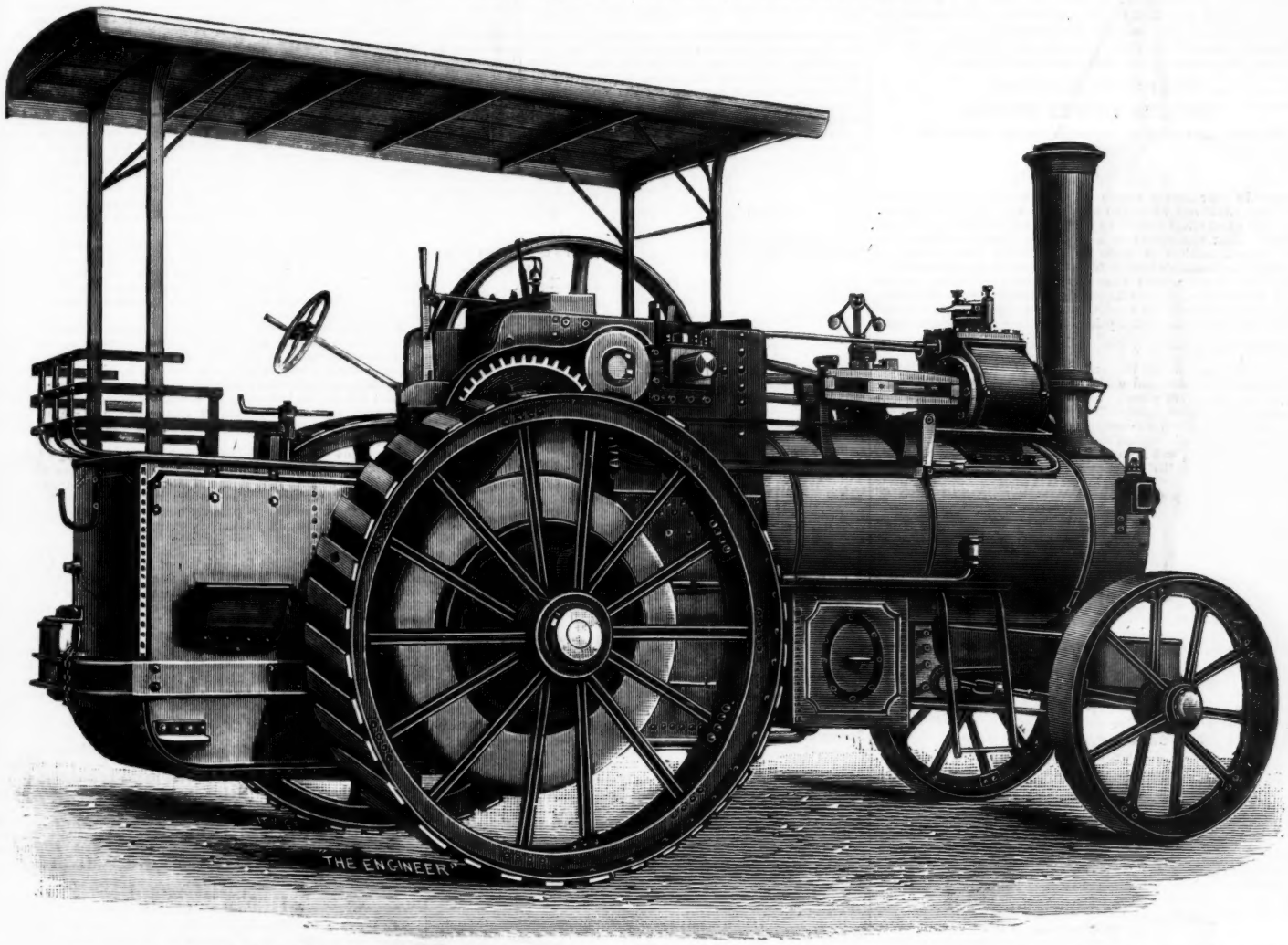
Owing to the strong rough wind of Thursday night, it was found impossible to send up the balloon to the height intended—namely, 600ft.; the system of signalling, however, was exhibited with the balloon only a short distance overhead which doubtless was a disappointment to the inventor but which was not altogether bad, because it showed what might be expected in a high wind. The balloon was filled with coal gas. Hydrogen has been preferred for balloon work in the service, and this balloon would, we believe, hold hydrogen perfectly well, in which case the decreased bulk would give less trouble in a wind. As it was, the signalling was apparent and conspicuous enough, but the height would not have enabled signals to be carried on between bodies of troops on opposite sides of a hill, as is intended. The speaking was decidedly slow work, probably not exceeding the rate of four or at most five words a minute. We do not think that undue stress must be laid on this; it is a great object to get trustworthy means of communication, and a great quantity of matter—in fact, all that is most necessary—can surely be said by a supply provided of 240 words per hour. The delay was due to the fact that the lamps glowed red, and gave a comparatively dull light at first. Consequently, to reach to a long distance, a dot had to be prolonged into what might be generally a dash, and a dash had to be made proportionately longer. This, however, is a minor matter, and one probably capable of improvement; in fact, we hardly see its necessary connection with the balloon system further than the limit imposed on the circuit by weight. Here the substitution of hydrogen might be utilised if preferred in carrying larger cable, in preference to using a smaller balloon. A frame of lamps is sometimes suspended from the balloon as an alternative to the interior lights, but this was not employed on this occasion owing to the high wind. The lamps inside the balloon are said to be not at all liable to be broken. In fact, we were informed that when a captive on one occasion broke away, and was eventually recovered after running its usual boisterous course, the lamps were uninjured. This might be expected, unless a large proportion of the gas should have escaped.

Altogether Mr. Bruce must be congratulated on his success. He undoubtedly shows that signals can be kept up on the principle he advocates, although the field of its application may be, we think, a limited one.

On the 1st of June an Exhibition was opened at Quito, the capital of the Republic of Ecuador, for the purpose of showing articles collected for the Chicago Fair, and also to give an opportunity to foreign manufacturers and merchants to display their wares. The first suggestion for this came from Mr. Tisdel, the Special Commissioner of the Columbian Exposition, and it was hoped that the industries of the United States would be well represented. The Latin-American Department is now informed that it is a matter of considerable surprise and comment on the West Coast that not one American house is represented at the Quito Fair, while Germany and England have sent many small wares and some agricultural machinery. American manufactures would have been admitted free of duty, and transported to Quito from the seaport of Guayaquil at the expense of the Government. The lack of response to the cordial invitation given to the merchants and manufacturers of the United States by the Ecuadorian Government is a great disappointment.

COLONIAL TRACTION ENGINE

MESSRS. RANSOMES, SIMS, AND JEFFERIES, ENGINEERS, IPSWICH

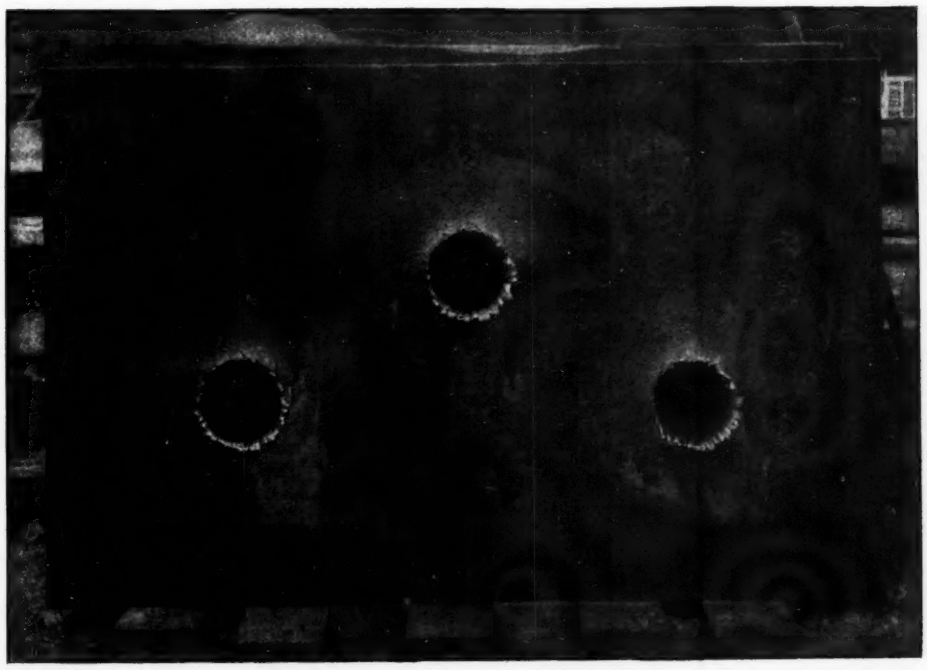


COLONIAL TRACTION ENGINE.

MESSRS. RANSOMES, SIMS, AND JEFFERIES have recently introduced a new series of traction engines fitted with inside gearing, and of a slightly heavier type than those hitherto manufactured by them. Above we illustrate an engine of the newly-designed description, specially equipped with fore tank, canopy over driver, &c. It will be seen from the illustration that great care has been bestowed on the design, so as to secure a simple and neat appearance. The engine is made from an entirely new set of patterns, and many improvements have been embodied in its construction, which have suggested themselves during Messrs. Ransomes' lengthy experience. These improvements—combined with substantial proportions—render the engine equally serviceable for heavy haulage purposes on the road, when not required for thrashing. The shell of the boiler is made entirely of steel plates, strongly stayed for a working pressure of 140 lb. per sq. in. The steam jacketted cylinder is 9in. diameter and 12in. stroke.

In this engine special provisions have been made for preventing priming, and during the most severe trials carried out to test these provisions, no trace of priming could be detected. The governors are connected direct to the equilibrium throttle valve. One bracket carries the governors, the valve rod guide, weighbar shaft, throttle valve spindle, and governor bevel wheels and pulley. Two countershafts have been introduced so that the fast and slow speed gearing may be arranged between the bearings, the two pinions are cast together and keyed to the crank shaft inside the box brackets, the double speed wheels slide on four keys cut out of the solid material of the countershaft. The bearings for the crank shaft, two countershafts, and main axle, are all inserted in the side plates of the fire-box shell, which are carried upwards and backwards for the purpose. Two transverse plates serve to stiffen the side horn-plates. Above the fast and slow speed wheels another plate is bolted between the side plates, which forms a tray, which carries the stop valve, lever, and rod, the clutch lever and fork, and the whistle.

The draw-bar is flanged out of a thick plate, and extends across the back of the tender. On each side, it will be seer, are welded deep straps which take the pull from the horn-plates, relieving the tender of all strain. A series of holes are provided in the channel-shaped draw-bar, so that the draught pin may be moved out of the centre if required, when the engine is turning sharp corners with a long train behind. The canopy over the driver, the rack for carrying wood in the tender, and the tank under the barrel of the boiler, are supplied to meet the requirements of the Colonies. Some portion of the exhaust steam is conveyed to the return pipe from the pump for heating the feed-water in the tanks. Sliding fire-doors are fitted to the fire-hole, as they take up much less room in the tender than swinging doors. The gearing is compactly arranged, rendering the engine particularly narrow over the road wheels, a point of importance in many districts. Wherever possible rivets have been used in preference to bolts and nuts for the gearing, &c. The driving wheels are 6ft. 3in. diameter and 16in. on face. Total width of the engine, 6ft. 8in.



DIAGONAL ARMOUR, U.S. STEAMSHIPS MASSACHUSETTS AND INDIANA

TRIAL OF NICKEL STEEL PLATES IN AMERICA.

THE illustration herewith is from the official photograph of a remarkable nickel steel plate which was tried at Indian Head in May last. It is a sample plate, 10ft. by 6ft. by 14in., representing about 250 tons of nickel steel armour for the diagonal bulkheads of the battleships Massachusetts and Indiana. The test consisted in firing three projectiles from a 10in. gun with a striking velocity of 1400ft. per second. The projectile employed weighed 500 lb. We are not informed of its nature, but unquestionably it was forged steel, judging from the appearance of the photograph, and also because we believe these projectiles only are used for proof in the United States trials. The perforation, calculated on the English system, is about 15in. of iron or 12in. of steel. Perforation therefore was not to be expected. The points of the projectiles, we are informed, did not appear at the back, and also that there was a total absence of cracking. In fact, the plate seems to be an excellent sample of nickel steel, exhibiting the characteristics of that nature of plate. While the plate was certainly not severely tested as to perforation, the shock per ton was considerable. The plate probably weighed about 15·39 tons, and the striking energy of the blow being 6795 foot-tons, the target received a shock of 441·7 foot-tons per ton of plate in each of the rounds.

In the Nettle trials the calculated perforation is about 10in. of steel, the plates being 10·5in. thick, which is much more severe than 12in. calculated perforation for the 14in. of plate given above, but the shock per ton in the Nettle is hardly 300 foot-tons, so that the nickel plate was on this occasion tried very severely as to shock, but not at all severely as to perforation. This trial was probably intended to bring out the special qualities of the plate, which it certainly has done. The plate would evidently bear the continued attack of guns which did not completely perforate

very well. It would be a fine shield for land fortification. For ourselves, we should like to have a shot at it with a gun of smaller calibre, striking with high velocity, so as to test it as to perforation without an unfairly heavy shock. It would certainly be unreasonable to fire the 10in. gun projectile with an energy sufficient to give perforation, unless indeed it were intended to test the plate to destruction, which eventually might be very interesting because it would bring out the limit of the power of good nickel steel to hold together.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRAKE HORSE-POWER.

SIR,—In your leading article on this subject you have pointed out most effectively where the shoe pinches in trials with brakes, viz., the great effect caused by even a small difference in the tail weight. That this should be so when the result is calculated by the present method is quite in accordance with theory, if Coulomb's and Morin's laws of friction are taken as approximately true. For if we assume that for the same substances, at the same temperature, the coefficient of friction is always the same, the relation between the tensions of a rope passing over a rough curve—the rope being on the point of motion and its weight being neglected—is expressed by the equation $e = {}^{\mu\theta} = \frac{T_1}{T_2}$. T_1 and T_2 are the tensions at the extremities of the rope, μ is the coefficient of friction and θ the circular measure of the angle subtending the curve passed over by the rope. If in the above equation T_1 be taken equal to 1014 lb. and T_2 to 70 lb., the values given in your leader of the weights on the brake in the first trial of Messrs. McLaren's engine, the value of μ becomes ·8530; while if $T_1 = 946$ and $T_2 = 4{\cdot}77$ lb. as in the second trial, μ equals 1·683, as will be seen from the following calculation, θ being taken equal to π in both cases.

$$e^{\mu\pi} = \frac{T_1}{T_2}$$

$$\text{Hence} \qquad \mu = \frac{\log. T_1 - \log. T_2}{\pi \log. e}$$

when $T_1 = 1014$ and $T_2 = 70$

$$\text{Then} \qquad \mu = \frac{\log. 1014 - \log. 70}{\pi \log. e}$$

$\log. 1014 = 3{\cdot}0055$ $\qquad$ $\log. \pi = 0{\cdot}4971$

$\log. 70 = 1{\cdot}8451$ $\qquad$ $\log. e = \overline{1}{\cdot}6378$

$\log. 1014 - \log. 70 = 1{\cdot}1604$ $\qquad$ $\log. (\pi \log. e) = 0{\cdot}1349$

$\log. 1{\cdot}1604 = 0{\cdot}0645$

$\log. \pi \log. e = 0{\cdot}1349$

$\log. \mu = \overline{1}{\cdot}9246$

$\therefore \quad \mu = {\cdot}8503$

Again, when $T_1 = 946$ and $T_2 = 4{\cdot}77$,

$$\mu = \frac{\log. 946 - \log. 4{\cdot}77}{\pi \log. e}$$

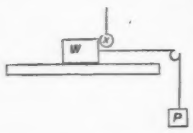
$\log. 946 = 2{\cdot}9759$ $\qquad$ $\log. 2{\cdot}2974 = 0{\cdot}3612$

$\log. 4{\cdot}77 = 0{\cdot}6785$ $\qquad$ $\log. (\pi \log. e) = 0{\cdot}1349$

$\log. 946 - \log. 4{\cdot}77 = 2{\cdot}2974$ $\qquad$ $\log. \mu = \overline{1}{\cdot}2263$

$\therefore \quad \mu = 1{\cdot}683$

The increase of the value of μ in the second example cannot be attributed to increase of velocity, for in the table on page 17 of the engine tests it will be seen that the velocity was less in the second trial than in the first. The inference seems obvious, that the difference between the weights on the brake does not represent the resistance due to friction, or in other words, does not represent the product of the coefficient of friction into the pressure on the rim of the wheel, *i.e.*, μ W.



Referring to my last letter on page 551, the following is a method of calculating the work done when x impinges against W (see Fig.) instead of against P. Let the conditions be as before and let $v_1 =$ the velocity of x at impact, and suppose this velocity be the same as that which would have to be given to the rough plane or to a fly-wheel to effect the same object. Let $\sqrt{2fs}$ = velocity of W at impact, then W and x being inelastic,

Momentum of P + W at impact $= -(P + W)\sqrt{2fs}$

and " " x " " $= x v_1$

Momentum gained by P + W after " $= 2(P + W)\sqrt{2fs}$

" lost by x " " $= x(v_1 - \sqrt{2fs})$

$$\text{Hence} \qquad x = \frac{2(P + W)\sqrt{2fs}}{v_1 - \sqrt{2fs}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let $2t$ = time between impacts;

then $\frac{1}{2t}$ = number of impacts per second,

and $\frac{1}{2t} = \frac{1}{2\sqrt{\frac{2s}{f}}} = \frac{f}{2\sqrt{2fs}}$

The kinetic energy of $x = \frac{x v_1^2}{2g}$, when x = weight of body in pounds. Hence

$$\left.\begin{matrix}\text{Total work done per second} \\ \text{+ energy remaining in } x\end{matrix}\right\} = \frac{x v_1^2}{2g} \times \frac{f}{2\sqrt{2fs}}$$

Substituting for x its value from (1), we get:

$$\text{Total work per second, \&c.} \left\{ = \frac{2(P+W)\sqrt{2fs}}{v_1 - \sqrt{2fs}} \times \frac{v_1^2}{2g} \times \frac{f}{2\sqrt{2fs}} \right.$$

$$= \frac{(P+W) v_1^2 f}{2g(v_1 - \sqrt{2fs})}$$

and when $s = o$,

$$\text{Work} = \frac{(P + W) v_1 f}{2g} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

When $s = o$ the whole of the energy in x is destroyed at each impact.

In the above expression $f = \frac{P - \mu W}{P + W} \cdot g$, so that if μ could be determined by experiment or otherwise, the work required to keep P suspended could be calculated.

Instead of having only one body x revolving about the axis c, we may suppose any number of such bodies revolving about the same axis with the same velocity, and so approximate as closely as we like to the action of a fly-wheel. It is not difficult to imagine the weights x, x, &c., to be made of some brittle substance, so that they smash up at impact against W, while fresh balls are by some means or other fixed to the rigid arms to replace the broken ones.

In the theory I am advocating, it is assumed that when a weight is supported by the friction between a body in motion and a body at rest, that the latter body receives on its rough excrescences a series of blows from the rough excrescences of the moving body, and this seems to me a simple and exact statement of what must be taking place.

If the value for work in equation (2) is equated with the value for work from (3) in my former letter, page 551, we get

$$\frac{P + W}{2g} \times v_1 f = P \frac{v}{2}.$$

$$\text{Hence,} \qquad (P + W) v_1 f = P v g,$$

and since $f = \frac{P - \mu W}{P + W} \cdot g$,

we get, $(P + W) v_1 \frac{P - \mu W}{P + W} \cdot g = P v g$,

$$\therefore \qquad (P - \mu W) v_1 = P v,$$

$$\text{and} \qquad \mu = \frac{v_1 - v}{v_1} \times \frac{P}{W},$$

an equation from which the value of μ may be found if my assumptions are correct, and which, therefore, I take this opportunity to respectfully recommend to the attention of the Committee of Mechanical Engineers conducting experiments on friction. The following method of determining the work required to keep the motion of a falling body P uniform by a series of bodies x x, &c., impinging against it brings out the same result for work as the method adopted in my former letter, but is a little more general in form:—

Let $V + \sqrt{2gs}$ = velocity of P at each impact,

and V = " P after impact.

Also let v = " each of the bodies x x at impact.

Then momentum of P at impact $= P(V + \sqrt{2gs})$,

and " x " $= -xv$.

Let momentum lost by P and gained by x = X,

Then momentum of P after impact = P V = its momentum before impact − X.

Hence $\qquad P V = P(V + \sqrt{2gs}) - X.$

Similarly $\qquad x V = -xv + X.$

Adding we get $V(P + x) = P(V + \sqrt{2gs}) - xv.$

$$\text{Hence} \qquad x = \frac{P\sqrt{2gs}}{V + v} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The work done per impact $= \frac{x v^2}{2g}$, x being taken as the weight of the body in pounds. If t = time between each impact, then

$$\text{the number of impacts per second} = \frac{1}{t} = \frac{1}{\sqrt{\frac{2s}{g}}} = \frac{g}{\sqrt{2gs}}.$$

$$\text{Hence,} \qquad \text{work done per second} = \frac{x v^2}{2g} \times \frac{g}{\sqrt{2gs}} = \frac{x v^2}{2\sqrt{2gs}},$$

and substituting the value of x from (1) we get

$$\text{Work} = \frac{P\sqrt{2gs}}{V + v} \times \frac{v^2}{2\sqrt{2gs}} = \frac{P v^2}{2(V + v)} \quad . \quad . \quad . \quad . \quad (2)$$

and when $V = o$, work $= P\frac{v}{2}$.

In the first part of this letter I have worked out a formula showing how the velocity of the fly-wheel affects the problem which may perhaps satisfy "Tester." His own experiences given in his letter show how untrustworthy is the accepted method of calculating brake horse-power. If Mr. P. Nichols will refer to page 523, he will see the omission of the denominator for horse-power corrected. Mr. P. Nichols I suppose knows that a velocity can be numerically equal to an acceleration, which is obviously my meaning. With regard to his remarks upon elasticity, they are hardly to the point, as I have expressly assumed in my proof that the impinging bodies are inelastic. Mr. P. Nichols is correct in saying that I have omitted to mention the energy remaining in x after impact. This was a slip, and I thank him for pointing it out; but I do think it is a slight exaggeration to call this a vital error, as it in no way alters the proof, and is taken into account a few lines further on. Instead of "Total work done per second," read "Total work done per second + energy remaining in x," and the "vital error" disappears.

July 6th. C. E. B.

SIR,—Your correspondent, Mr. C. J. Hancock, gives two examples of brake conditions; one with a load of 1000 lb. and a tail pull of 10 lb., and another with a load of 2000 lb. and a tail pull of 1010 lb.

There is no reason whatever why the actual work done by the engine should not be the same in the two cases, provided that the coefficient of friction in the latter case *could be* so small that the engine would turn and still preserve the conditions of 2000 lb. load and 1010 lb. tail pull, and provided that—a most important point in brake tests that have any pretence to accuracy—there is no lubricant of any description used. Such conditions as those of 2000 lb. load and 1010 lb. tail pull might easily obtain if the brake strap or rope only wrapped round a comparatively small arc of the brake wheel circle; and given a dry brake, I fail to see any reason why the results should not be in strict accordance with the difference between the load and the tail pull.

Given a wet brake, and conditions are altered, for there must of necessity be a film of the lubricating material between it and the wheel. That film cannot be in a passive condition with one side of it in close contact with a fixed surface, and the other with a rapidly moving one. The particles of lubricant on the one side must be sheared away and rubbed over those on the other, just as one may see on a large scale when a steamer is sailing through a phosphorescent sea in the tropics. The sea close to the vessel is brilliant because the latter's rough skin is agitating one set of watery particles and making them shear themselves away from, and rub over, another set a little further away. This latter does ditto to the next set beyond it, and so on, until the primary effect is annihilated by reason of the work done among the particles of water themselves. So must it be with our brake film which will naturally be in a very perturbed state, and part of the work done during that perturbation cannot be registered by the brake. In plain language, there must be a greater resistance to the motion of the wheel than is actually recorded. This difference is an unknown quantity, and can only be arrived at by experiment. Moreover it must vary with different conditions of lubrication, and it is most reasonable and natural to suppose that the wetter the brake the thicker the film between it and the wheel, the pressures being supposed the same. Therefore it is clear that less of the engine work is recorded by the brake, more being expended in agitating the particles of the lubricant.

The very fact that we have to use more tail pull with a wet brake than with a dry one proves this, since it shows that slipping is taking place which did not obtain before, and which can only be among and between the particles of lubricating material. I do not believe that there is anything wrong about a dry tail brake, and I certainly do not see why Messrs. McLaren's staff should spend their time over discussing a most natural and simple phenomenon, nor yet why any of your mathematical correspondents should accept Messrs. McLaren's invitation and waste their time mathematicising over a wet brake, the peculiarities of which are not apparently understood, but half an hour would suffice for the mathematics (*sic*) of a dry one. Of course, in the latter case the coefficient of friction varies, but I see no reason to doubt that the effect of that friction is duly recorded, whereas with a wet brake it cannot be, for the reasons that have already been suggested.

Now, why should not the brake wheel be covered with, say, hard wood, and the brake strap be made of sheet metal with an india-rubber back to it, water being forced to circulate between the thin sheet metal and the rubber?

In the sketch, A is the brake wheel rim, B the wood, a b the sheet metal, c d the india-rubber before and during the water circulation. Tail springs and the load may be applied as usual, the sheet metal band a b being of such a circumferential length as may be considered desirable. No lubricant need be used at all, for a b would certainly run cool, as also the wheel B; yet if this were cooled as described by you in your interesting article upon the subject, or as done by Messrs. McLaren, it is highly probable that B might be dispensed with altogether and the brake run metal to metal. Anyone can try this at very small expense, and I am sure that results by its means would at all events be consistent.

One thing is evident from Messrs. McLaren's engine trials, namely, that the jackets are not worth the money they cost, if in truth they are worth anything at all, and in my humble opinion a really well-designed triple-expansion engine, built according to the present prevailing notions, is just as well without as with them. But supposing, for the sake of argument, they are of some use, and supposing I make up my mind to jacket one or two cylinders as the case may be, can anyone, or rather, is there any unanimity of opinion amongst, say, the Research Committee, as to which one, or which two of these cylinders I should jacket? I trow not, and I should like to know what it is the aforesaid committee and professional engine testers have got at, that engine makers did not know before they began operations.

How can jackets possibly be of much use with three great lumps of metal in the shape of pistons, wagging up and down at a temperature considerably below the mean of the inlet and exhaust steam in each cylinder? But jacket these pistons and their rods internally, together with every other exposed surface, with steam at a high pressure, higher even than that in the boiler, and there will be a different tale to tell. It might then be possible to arrive at some approximation to a steam engine theory, which is assuredly impossible now.

Steam then would have a chance of working as steam, and not as a polyglot mixture of steam and water. It is of no use to generate steam at 160 lb. per square inch, and then condense it against a cold piston face before doing a foot-pound of work, evaporate it at a much lower pressure, condense it again against another cold piston face, and so on.

Keep the steam as steam inside your cylinders, as far as you know how, right away through the performance of work. Let it even be superheated at the close; it can easily be made to pass through the feed-water that is on its way to the boiler. Jacket everything in the manner indicated, and high economy must be the result; but partial jacketting is, I humbly concede, of no use in the presence of a comparatively small surface of naked metal, which is of a necessity cooler than even the mean temperature of the inlet and outlet steam.

This is one way in which the present steam engine may be made more economical. But this present steam engine does not work at all in the manner that it should do; a radical change is both possible and probable. The nature of that change I am, for obvious reasons, unable to publicly communicate at present.

St. Neots, Hunts, July 11th. ANTHONY S. BOWER.

SIR,—In your footnote to our letter of last week you say we are scarcely fair with you, and ask why Mr. Hartnell and Professor Goodman should be called in, on January 19th, to witness an ordinary shop run. We may state that neither of these gentlemen were present at that test. If you refer to the letter which we sent along with the particulars of the tests, you will find that it reads as follows:—"We simply enclose the reports of the Inspecting Engineer. On the 19th January the engines ran without steam in the jackets, and on the 21st the jackets were used. You will observe that the report is signed only by Mr. Watson, the engineer referred to. But at the second test we called in Messrs. Hartnell and Goodman, whose reports agree in every particular with that of Mr. Watson."

Mr. Watson was present on the 19th. (The Inspecting Engineer is like the poor—he is always with us.) The test he made on that date was as carefully conducted as the official test on the 21st, only the engine was not sufficiently "fined down" to test the efficiency of the steam jackets by the brake.

Now we think you will see that we have been quite fair with you. We are anxious to be so, as we wish to be told where the error (?) lies in the tail rope brake. So far, none of your correspondents have scored a point against it. J. and H. MCLAREN.

Leeds, July 12th.

A PROBLEM IN GYROSCOPES.

SIR,—Other experiments can be made with the gyroscope besides the common one, which recent correspondents appear to have exclusively treated; and perhaps a knowledge of more than the one experiment may assist investigators in understanding the actions involved. The fly-wheel ring may be mounted in a ring turning about a vertical axis, the centre of gravity of the wheel coinciding with the centre of the system; whilst a separate weight may be applied to show the action of gravity. In this arrangement a solid concentric sphere may be substituted for the ordinary fly-wheel. In another arrangement an ordinary gyroscope, weighing with its ring about 1½ lb., may be fixed on an arm at about 12in. from the fixed centre of support. The arm should be extended beyond the centre, and have a weight applied to partially counterbalance the weight of the gyroscope. The gyroscope should be placed with its spindle radiating from the fixed centre. If in this arrangement the gyroscope is spun in the ordinary way, and let go with the arm horizontal, it will not go round horizontally as in the common experiment, but will describe a succession of cycloidal curves.

When the gyroscope is spinning—in the common experiment—the downward pressure of its centre of gravity is transferred to the fixed centre of support. I have apparatus, made thirty-five years ago, showing this very plainly. There are, however, other pressures or strains involved. If instead of the point of support being fixed it is arranged so that it can move freely in any horizontal direction, the gyroscope will revolve about a vertical axis passing through the centre of gravity of the system. With great care this action can be shown when suspending the gyroscope by a thread, but it is difficult to avoid pendulous movements which complicate the action.

Let us suppose an ordinary gyroscope to be fixed at the outer end of a short arm, which at its inner end is by a universal joint—as free as possible from friction—connected to the bottom end of a stationary vertical bar fixed overhead in any convenient way. If the gyroscope is placed with its arm horizontal, and let go, the fly-wheel not being in rotation, it will descend until vertically below the point of support; it will not stop in that position, however, but, like a pendulum, will swing upwards again on the opposite side. In the absence of friction and air resistance it would rise to the height from which it fell, and it would continue repeating semicircular pendulous swings.

Next let us suppose a little spin to be given to the fly-wheel, and the gyroscope be let go as before. What will happen? Here our old friend the parallelogram of forces comes in as applied to show the composition of rotations. The semicircular pendulation is a partial rotation about a horizontal axis at right angles to the axis of the fly-wheel, and the resultant axis will be in the two quadrants in which the movements due to the two rotations would, separately, be opposite to each other. The pendulation axis being at 90 deg. from the fly-wheel axis when there is no spin, a small spin will cause the resultant axis to be somewhat less than 90 deg. from the starting position of the gyroscope; and with such small spin the pendulation taking place about the resultant axis will cause the gyroscope to rise up to a point correspondingly less than 180 deg. from the starting point. Having so risen up, the gyroscope will not with the next swing return to the original starting point, but will pendulate about a new resultant axis as many degrees further round from the new starting point as the first resultant axis was from the original starting point.

Increasing the spin reduces the angle between the starting-point and the resultant axis; and with such a spin as is usually given, the resultant axis is very near the starting-point. If the rotator is a solid sphere carried in rings, so as to be virtually supported at its centre, a separate weight being applied to one end of the spindle to produce gyroscope action, the continuous action of the weight will cause the spindle end to describe a series of spherical cycloids which are smaller and shallower the greater the spin—that is, if we leave out of consideration the influence of friction, air resistance, and the inertia of the rings, all which have effect in modifying the curves described.

It is important to notice that what has been termed the resultant axis, and which, with continued action of the weight, is an "instantaneous," or continually changing axis, is not coincident with the axis of the fly-wheel spindle—except at the instants of describing the cusps of the cycloids; and in the case of the common gyroscope, with its fly-wheel at a few inches from the point of support, that wheel has a corresponding slight inclination to the instantaneous axis—except when at the cusps. This inclination of the wheel to the instantaneous axis causes the horizontal components of the centrifugal tendencies of the several parts of the wheel to be slightly unequal or unbalanced, and to give rise to a resultant force couple tending to move the spindle towards the instantaneous axis, and which, by composition of the rotations, causes the instantaneous axis to be slightly higher than it otherwise would be. When the spindle has descended a part of the cycloidal curve, the centrifugal couple still tending to move it towards the instantaneous axis, that axis takes a relative position somewhat behind as well as higher than what it would otherwise have, with the result that the spindle becomes directly below the instantaneous axis, or very nearly so, and the spindle and instantaneous axis both move horizontally.

Put shortly:—With the common gyroscope the arrangement results in there being an instantaneous axis, which moves round continuously, and is always above the outer end of the spindle of the wheel, and the effort of the wheel's rotation to carry the end of the spindle round the instantaneous axis, and in so doing to carry it upwards, conterbalances the downward effort of gravity. At the same time the tendency of the operative actions is to cause the instantaneous axis to pass through the centre of gravity of the wheel, and to be below the inner end of the spindle, and this tendency in the effort to carry the inner end of the spindle round and downwards, depresses it on the point of support with a pressure precisely equal to the weight of the gyroscope.

Glasgow, July 4th. AMATEUR MATHEMATICIAN.

PRICES OF GOODS AT CHICAGO.

SIR,—Complaint has been made that the regulations of the Director-General prevent exhibitors from showing what their prices would be if free of duty, because exhibitors will be compelled to sell at whatever price is affixed to their goods. But I wish to point out that the price may be so stated, and yet show by inference the burden of the duty.

Take an article, for instance, which sells for £100, or say 500 dols. in England, and on which the duty is 50 per cent. *ad valorem*. As the duty is imposed on the packages, as well as on the goods, and as a commission or profit of say 15 per cent. would probably be added to the duty by whoever advanced it at the Custom House, the addition for duty as paid by the American buyer would be about 300 dols. The placard announcing the price might read:—Price in England, 500 dols.—freight, 20 dols.; net price in Chicago, duty paid, 820 dols. INTENDING EXHIBITOR.

Yorkshire, July 11th.

[We understand that at the instance of Sir Trueman Wood the objectionable circular has been withdrawn.—ED. E.]

ENGINEERING IN EGYPT.

SIR,—In the professional papers of the corps of Royal Engineers, vol. xviii., paper ii., 1892, has appeared an article on the great Koshesha Escape in Upper Egypt. By one who did not know the facts of the case it might possibly be imagined that the work had been designed and built solely by Royal Engineers. As a matter of fact Mr. A. G. Reid, C.M.G., M.I.C.E., of the Punjaub irrigation service, designed the whole of the regulating apparatus, the ironwork, and part of the masonry, as he did that of every big work built in Egypt since 1887. The resident engineer in charge of the work during construction from the first day to the last, and to whose insistance on the foundations going deeper than was originally designed the work owes much of its stability, was Mr. W. M. Hewat, A.M.I.C.E., of the Egyptian irrigation service. As Royal Engineer journals apparently mention no names except those of Royal Engineers—even when they have had nothing whatever to do with the work—it has happened in this case that the two men who practically did the work have not been mentioned because they were civil engineers.

W. WILLCOCKS, M.I.C.E.,
Cairo, July 2nd. Director-General of Reservoirs.

THE PADDLE STEAMER KOH-I-NOOR.

SIR,—In your article of July 8th on this steamer, after stating that a mean speed of 19½ knots an hour was obtained on the measured mile, it is added that she had thus "proved herself to be the fastest river steamer afloat." I venture to correct this, as I was connected in 1890 with the building of a very similar steamer, the paddle steamer Hygeia; this boat attained a mean speed of 19·8 knots on two runs between the Cloch and Cumbrae Lights. The following particulars, taken from *Lloyd's Register*, will show the similarity of these steamers in dimensions. I also understand the draughts of water on trial were practically the same:—

	Built	Length.	Breadth.	Depth.	Speed on Trial.
P.s. Hygeia..	1890	300ft.	32ft.	11 3ft.	19·8 knots
„ Koh-i-noor	1892	300ft.	32ft.	11ft.	19 5 „

21, Bothwell-street, Glasgow, July 12th ROBERT MORTON.

HYDRAULIC OR JET PROPULSION.

SIR,—The history of this mode of propulsion, concerning which latter there has been some correspondence in your columns recently, is as old as that of steam navigation; but the progress attained has not been in the same proportion. The greatest advance in propelling vessels by this mode is a speed of 10 knots an hour, while a speed of 4 knots an hour was obtained with the imperfect and rude appliances of a hundred years ago. The following account of an experiment on hydraulic or jet propulsion at the end of 1792—or the beginning of 1793—may interest some of your readers:—"February 27th, 1793.—The vessel of the late Mr. Ramsey to sail against wind and tide was lately tried, and was found to sail about 4 knots an hour. The principle on which it moves is a pump of 2ft. diameter wrought by a steam engine forcing a quantity of water up through the keel; the valve is then shut by the return of the stroke, which at the same time forces the water through a channel or pipe about 6in. square, lying above and parallel to the kelson, out at the stern under the rudder, which has a less dip than usual to permit the exit of the water. The impetus of the water forced through the square channel against the exterior water acts as an impelling power upon the vessel." C. P.

Westminster, S.W., July 9th.

THE DIMENSIONS OF MODERN WARSHIPS.*

By Capt. S. M. EARDLEY-WILMOT, R.N.

OVER thirty years have elapsed since the present reconstruction of our fleet commenced. The main point I wish to bring forward in this paper for discussion is, whether we cannot now, after an experience of thirty years, formulate some definite rules on which the construction of a fleet should be based; the types of ships it should include, and their dimensions. It may be said this is impossible. Ships building to-day will be obsolete ten years hence; guns considered effective now will be shortly superseded by totally different weapons. This style of argument is much in favour; but I hold it is quite fallacious. We have ironclads now over twenty years old, which are still capable of most excellent service; and, indeed, our most modern types rather indicate a return to that so-called obsolete system of construction. It should be remembered that now, more than ever, it is essential that, at the outbreak of war, we should possess a large number of ships. As Nelson wrote:—"It is not merely a splendid victory of twenty-three ships over thirty-six which the country requires; that which we need is, that the combined fleet should be annihilated, and it is only *numbers* which can annihilate." But, if it was important then, how much more so now, when it is considered marvellous work completing a first-class ironclad in three years. In the old days a line-of-battle ship could be built and equipped within six months.

Now, before entering upon the question of types and dimensions of modern ships, it will be interesting to observe how experience in the old wars led to the clearly-defined grouping we see in the naval construction of that day. To those who wish to follow the various stages by which we passed from the strangely-assorted fleet successfully paralysing the efforts of the Spanish Armada without any very clearly-defined plan of action, to the formation of a line of battle composed only of ships of a certain rating, I cannot do better than to refer them to the chapter on "The Differentiation of Naval Force" in Admiral Colomb's excellent work on "Naval Warfare." Here I only propose to dwell upon the outcome of long experience and many wars in producing a class of ship in great numbers which was not the most powerful of that day, but could, and often did, successfully cope with the best the enemy brought against us. At that period, the guns not varying much in size, the measure of a vessel's strength was the number of ordnance carried, and this could only be increased by additional tiers, which determined whether she was to be a two or three-decked vessel. There were such things as four-deckers, but the species was rare, and I do not think we ever produced any of this class. There was a model of one proposed—the Duke of Kent—in the Naval Exhibition, but she was not built. We may consider the three-decker the largest battleship of that day, carrying from 100 to 120 guns. Forfait, the celebrated engineer, once said: "It is really the cannon which alone gives the law at sea." Those wooden ships never attempted to ram each other. They feared to lose their masts, and only as a last resort and preliminary to boarding were hulls intentionally brought into contact. As also the underwater attack was then unknown, the natural inference might be that for the line of battle only ships of the largest class would be built carrying the greatest number of guns. As a matter of fact, however, this was not the case. Two-deckers of various classes were constructed in the greatest numbers. When it was found that the smallest class could not cope in the line with the heavier craft to which they might find themselves opposed, their construction was abandoned, and the favourite type became the 74-gun ship. It was found that this class stood the blockading work better than the three-deckers. They drew less water, and usually had superior sailing qualities, while they could hold their own against the largest vessels of our enemies. They were not all of exactly similar dimensions in hull or spars. Indeed it is recorded that when off Cadiz Nelson had no less than seven different classes of 74-gun ships under him, each with a different establishment of stores and spars, so that if any one was disabled the others could not readily supply her wants. The 74-gun ship, then, was the type which the true test of war had demonstrated in those days to be required in greatest numbers. During the long peace which followed after 1815 they were gradually superseded by larger vessels, until in the Baltic, forty years later, their want was again felt. Sir Charles Napier wrote: "We seem to have quite forgotten that there are such seas as the North Sea and Baltic, where small ships of two and three decks are indispensable. There are also many places where the like qualification is necessary, and I well recollect during the siege of Cadiz we were obliged to look up all our old 64's with a light draught of water, so that they might lie clear of the enemy's shells. Another thing we seem to have forgotten, that all the work of the war was done by the 74's, and that the large ships did not stand the blockade as well as the small ones."

Though we did not towards the close of the long war discontinue entirely the construction of three-deckers, the number built was few, and they were kept chiefly as flagships on account of the increased accommodation they afforded. Under similar reasoning we should, I think, at the present time have a small number of ironclads of larger bulk than the majority. Passing over that brief period of steam wooden ships which did not last long enough to undergo any crucial test, we come to the reconstruction of the fleet with ironclad battleships. As representing the three-decker, we built the Warrior, of 8820 tons. The increased weight was due to armour, machinery, and coal. In view of the effect of shell fire, as demonstrated at Sinope and Sebastopol, it was considered essential that a large portion of the hull should be covered with iron plates 4½in. thick, which involved, with the backing, a weight of 1350 tons. The result was a noble vessel in which the protection was not given undue prominence. Approximately one-sixth of the total weight was devoted to what may be called the passive defence. As we now allot nearly one-third of the displacement to armour protection in one form or another, the change in this respect can be understood.

The feature of moderate displacement was displayed in such vessels as the Rupert, of 4400 tons, also the Conqueror and Hero, of 6200 tons. But for some years we have discontinued building any battleship of less than 9500 tons, and our latest so-called second-class ironclads, the Centurion and Barfleur, are to be of 10,500 tons displacement. These will, I believe, prove most admirable vessels; and the point in my mind is whether we should not add largely to this class, and limit our supply of the bigger type—at any rate for the present—to those we already possess. Let us see what we can combine in a vessel of 10,500 tons as exemplified by the Centurion. First there are four 10-in. 29-ton guns; a pair of them being contained in a barbette at each end. Though the movement of the turntable on which these guns are mounted is actuated by steam power, the operation of loading and making ready to fire is performed by hand. This by many is considered an important point. Armour to successfully resist perforation by these weapons must be limited to a small area of the hull, and consequently the target it affords may be neglected in favour of the attack of those parts protected only by thin armour, or without it. Associated with these powerful guns is an auxiliary armament of ten 4·7in. quick-firing, or more properly speaking, quick-loading guns. The power of recharging a gun rapidly is equivalent to a greater number; but this very quality will tend to hasty aim, which must need constant supervision and firm control. As regards protection, we are able to have a belt of steel, or compound armour, 12in. thick for 200ft. of the water line, out of a length of 360ft. This is sufficient to resist penetration of all common shell, and almost any other projectile that can be brought against it under the varying conditions of a sea fight.

When in the early stages of ironclads the growing power of the gun had demonstrated that hardened projectiles could be sent through 8in. or 9in. of wrought iron, we should at once have sought to increase the hardness of the plate, instead of adding soft material until we had attained to the monstrous thickness of 24in. It was only under the stress of foreign competition, and after seeing what the French steel plates were capable of, that our manufacturers turned their attention to a new material and produced compound armour. This has been still further improved lately, and can successfully resist the best steel projectiles. I think, therefore, we may limit the thickness in all cases to 12in. In addition to this vertical and external armour the Centurion has the now usual armoured deck, and more protection to the auxiliary battery than has hitherto been given in the Admiral class of equal displacement.

As regards speed, though it is the most valuable quality in a cruiser, I do not think we should sacrifice too much for it in battleships. They will ordinarily be in company, maintaining a speed of about 10 knots. Circumstances may require this to be increased, and when on detached service it would be important to have the ability to keep up a speed of 15 knots for a considerable period. This should be well within the powers of the Centurion and Barfleur, which are to have a natural draught full speed of 17 knots. As the coal stowage for these vessels is sufficient for 1000 tons, good provision is made for this important item.

The weight involved by a torpedo equipment is relatively small, so that this weapon can be fully developed in a ship of moderate dimensions. We find, therefore, that in a vessel of 10,500 tons we can combine a powerful armament, sufficient protection to the structure, and an adequate speed. When increased dimensions are given, the additional tonnage is chiefly taken up in providing more armour. Here it may be interesting to observe by the following table the progressive increase of displacement and amount of armour carried in the three decades since ironclads superseded wooden ships:—

Year.	Ship.	Total displacement.	Total weight of armour and backing carried.	Maximum thickness of armour.
		Tons.	Tons	Inches.
1862	Warrior	8,820	1,350	4½
1872	Devastation ..	9,350	2,900	12
1882	Inflexible	11,500	3,500	24
1892	Royal Sovereign	14,200	4,500	18

By this we see that not only has the proportion between total displacement and armour carried materially altered, but that the latter in our most recent construction is practically half the entire weight of our first ironclad, and equal to the displacement of a large cruiser. It must be remembered that this armour is all devoted to sustaining the ship against gun fire; that it makes her no more capable of withstanding the blow of a powerful torpedo or ram than if she were unarmoured, and that it necessarily curtails other qualities which, if vigorously applied, will probably prove the best defence.

Let us now consider the relative advantages and disadvantages of large ironclads. First, there can be no question that by adding to the displacement an individually more powerful ship can be produced. But if this argument is considered sufficient to outweigh all others, on what ground should we stop at 14,000 tons? A vessel displacing 20,000 tons can be built in which every quality I have alluded to can be proportionately improved. It is only a matter of time, money, and material. This reasoning also applies to the argument that concentrated force in a single vessel is more effective than when distributed over a greater number of less power. In the discussion on the designs of our new battleships at the Institution of Naval Architects, Sir Geoffrey Hornby endorsed this view, but added, "I think it better we should have ships of medium size." He alluded to the disadvantage of very big ships in the matter of harbour and wharf accommodation. There is also the question of draught of water and existing docks rendered useless for large ironclads. These may seem comparatively unimportant details, but Commanders-in-Chief have in peace time to give much attention to these points, and in war time they might preclude the use of what would otherwise form a very convenient base of operations. Though some are of opinion that the Suez Canal cannot be relied on during actual or contemplated hostilities for the concentration and passage of warships, it is at present debarred to the greater number of our modern ironclads owing to their deep draught.

The strategic advantage of two ships over one in covering a larger area of sea or coast can hardly be disputed. The power of detaching small squadrons from the main body for any service, without materially weakening the latter, is greater when the ships are individually less powerful but more numerous. We cannot overlook such points as time and cost of construction. If we have brought the period of completion of such a ship as the Royal Sovereign within three years, we may safely assume that the Centurion, and others like her, can be built and sent to sea in two. The gain of one year is important, and we may yet find methods of reducing the time.

As regards cost, the first-class battleship of to-day represents an approximate expenditure of a million sterling, as against about £400,000 for the Warrior, which in turn was about double the cost for the old three-decker. It is a serious matter for reflection, when we find eight vessels costing as much as twenty of our early ironclads, and nearly equal in value to all the ships engaged on both sides at Trafalgar.

We now come to the influence which the ram and torpedo have on the dimensions of ships, and they appear to me to turn the scale in favour of moderate tonnage and greater numbers. While we have continued to pile on armour to resist the above-water attack, that portion below the water-line is still vulnerable, and cannot be made impervious to the effect of an explosion in contact, or the impact of another vessel at even moderate speed. In the case of two squadrons pitted against each other, in which one has a greater number of individually less powerful ships, the extra rams and torpedoes it puts into the line of battle give an accession of strength which may decide the issue at a critical moment. Thus, if we distribute 114,000 tons—which is the aggregate of eight vessels, each of 14,250 tons—among twelve of 9500 tons—which gives the same total—we have four additional rams and twenty-four, say, torpedo tubes. Twelve is not an inconvenient number for a squadron, and the power of bringing into play a few fresh ships at any moment of the action is a great advantage. It decided the day at Trafalgar.

Time will not permit me to deal at length with the dimensions of cruisers. In their case we do not find quite the same parallel with the past as with battleships. If ever we have a maritime war again approaching in duration that which terminated in 1815, I think we shall find that the cruiser of about 4000 tons is found the most useful type, and our requirements in this respect will be large as regards numbers. The bigger cruisers will merge into second-class battleships specially constructed for distant stations, while important work will be found for smaller vessels between 2000 and 3000 tons.

I am not in favour of devoting any considerable weight to armour in cruisers. They will be overcome in battle, I take it, by the disabling of their *personnel*, and in these days of rapid fire and machine guns, if any protection can be given, the crew should have a fair share of it. It seems to me we have got into the habit of considering ships in the light of not how hard can they strike, but rather how much hitting they can stand, and though it is perfectly legitimate to guard vital points, the best defence is, after all, vigorous offensive action. It is difficult to lay down any arbitrary law, but in the light of one who might have to take a cruiser into action, I should be quite satisfied if not more than one-twelfth of the displacement was devoted to protection.

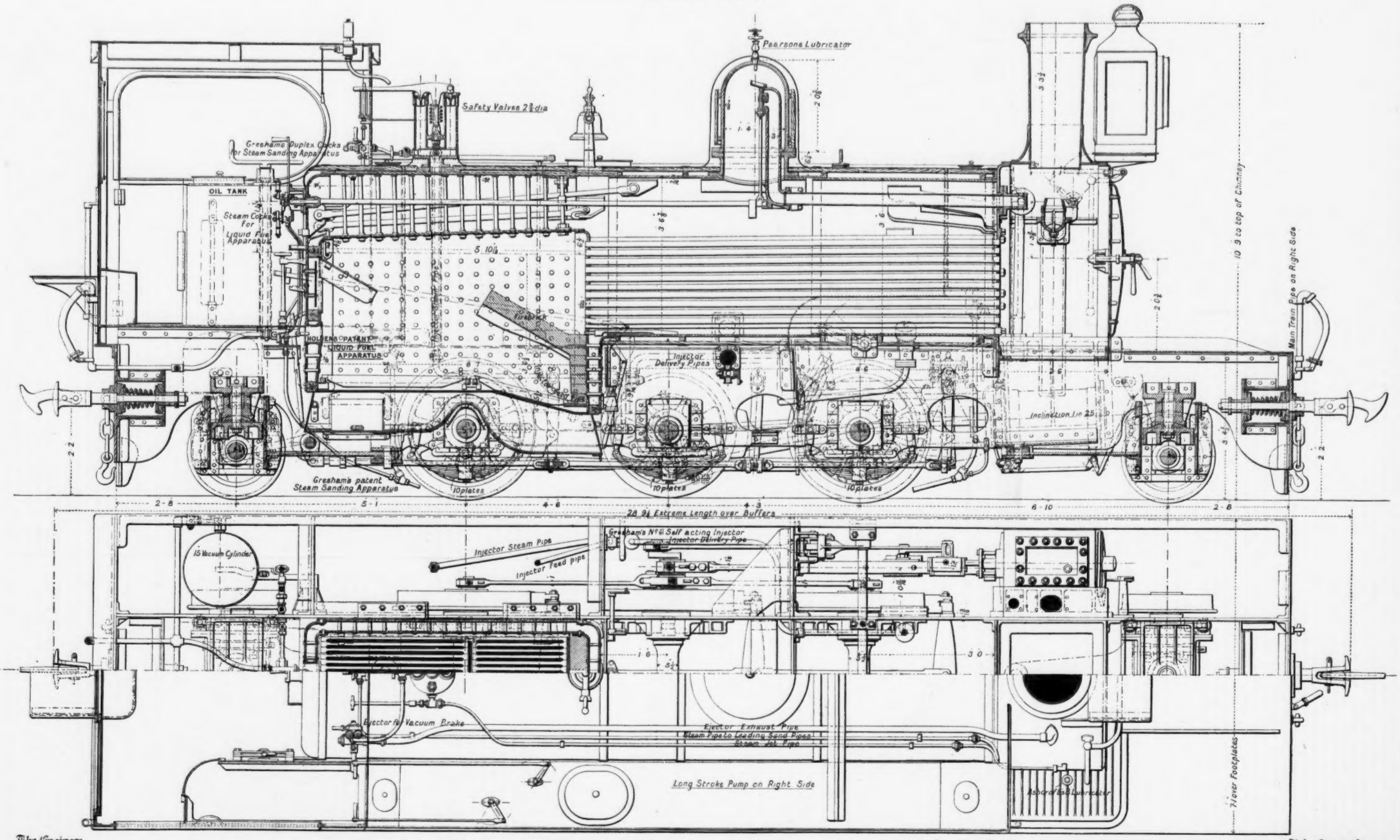
*Abstract of paper read before the Royal United Service Institution.

CAPITAL AND LABOUR IN CANADA DURING THE PAST DECADE.—The report of the industrial census for the Dominion of Canada during the past decade contains a number of interesting statistics contrasting the conditions of capital and labour in industry in 1881 and in 1891. The general result is given in the following series of conclusions:—(1) There has been a large increase in the number of hands employed, a large increase in the wages paid, and the largest increase is in the capital invested. The increase in the capital invested points to a large outlay for improved machinery, a fact, however, which cannot be shown from the figures themselves, as there was in 1881 no sub-division of "capital invested" into that invested in machinery and tools. (2) The average workman in 1891 was a more skilled hand than he was in 1881, inasmuch as he turned out 6 per cent. more of finished products in value than in 1881. (3) The average workman in 1891 earned 16 per cent. more wages than he did in 1881. (4) As every dollar invested produced in 1891 less than in 1881, the capitalist has had to be content with smaller profit. (5) Notwithstanding the reduction in the gross profits of the manufacturer, the workman has received a larger share of the total value of the products by 9 per cent. (6) The cost of raw material was on the whole higher in 1891 than in 1881.

NARROW GAUGE LOCOMOTIVE, TRALEE AND DINGLE RAILWAY

THE HUNSLET ENGINE COMPANY, LEEDS, ENGINEERS

(*For description see page 55*)



The Engineer. John Swain. Eng.